

GABB'S
CALIFORNIA CRETACEOUS
AND TERTIARY TYPE
LAMELLIBRANCHS

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**GABB'S CALIFORNIA CRETACEOUS AND TERTIARY TYPE
LAMELLIBRANCHS**

BY RALPH B. STEWART.

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I. INTRODUCTION

In the 1926 volume of the Proceedings of this Academy, the original material of the gastropods described by W. M. Gabb from California was revised and illustrated. In this paper, the lamellibranchs or pelecypods from the Cretaceous and Tertiary have been treated in a similar manner. A discussion of the material and of some of the localities will be found in that paper.

Since much of the material is poorly preserved, the generic determinations in many cases rest upon a study of well-preserved specimens of presumably related species of Eastern America and Europe. The matrix and type of preservation of the specimens have been compared with those of the gastropod types. A mineralogical analysis of the matrices of the types might prove helpful in later identifying the exact localities of the types but I am unable to make such an analysis. The notes on the matrices are superficial, dealing with the state of preservation, staining and lustre, and will doubtless be of little geological interest, though they have been of use in the study of this collection, and may be useful in studying other material of the California Geological Survey which may be found.

Some apology is due for the large amount of space given to nomenclatorial problems. Whether these notes will bring us any closer to a universal nomenclature may be questioned. I have attempted to restrict genera and particularly subgenera to groups which may be said to have a reasonably definite geologic and geographic distribution and in so doing it has seemed worth while to attempt to discover the correct names for these animals under the International Rules of Nomenclature. Deliberate departures from the Rules have been indicated and will eventually be submitted to the International Commission for consideration. It is difficult to say just how much reliance can be placed on my statements of distribution—

usually qualified—but they may prove useful. Extensive monographs of each family are of course what is needed but it will doubtless be a long time before such works are available.

Some lamellibranchs from the older horizons, mostly from Nevada, were also described by Gabb in the "Paleontology of California," and in the 5th volume of the "American Journal of Conchology," 1869. These have not been listed in this paper for I have not studied them. At least some of the material on which they were based is now in the Whitney collection of the Museum of Comparative Zoölogy at Harvard University, and some of the types were recognized by Hyatt* (Geol. Soc. Am. Bul. 5, 1894, p. 395-434).

As compared with the Cretaceous and Eocene fossils, Gabb's work on the Post-Eocene fossils is not so important because only a few species were described by him. The most important work, also earlier than Gabb's, is that of T. A. Conrad, and while many of his types have been studied by Dall (1909), an illustrated revision of Conrad's material, much of which is now in the National Museum, is highly desirable, and from the point of view of students of Neogene Mollusca of the West Coast, might well have preceded the revision of Gabb's work. It is hoped that someone will be able to study and illustrate Conrad's material for the lack of such a work has considerably retarded the study of West Coast Neogene Mollusca.

This paper was submitted for publication in April, 1929, and contains few references to papers published after 1928.

II. ACKNOWLEDGMENTS

Dr. Henry A. Pilsbry, Special Curator of Invertebrates of the Academy of Natural Sciences of Philadelphia, has permitted me to study the Academy's material. As in the work on the gastropods, Dr. Pilsbry has taken much interest in this study which has been of the greatest benefit both to this paper and to myself, and I am much indebted to him. His mature judgment, based on a lifelong study of Mollusca, has guided me in many of the decisions made in this paper. For the opportunity to study at the Academy, without whose great library and collections the more interesting discoveries recorded here would have been impossible, I am indebted to Dr. Pilsbry and to the former President of the Academy, Dr. R. A. F. Penrose, Jr., under whose administration the work of revising the Academy's collection of California type Mollusca was begun. Dr. Penrose has also generously contributed toward the cost of publication of this paper, and Dr. Pilsbry and Mr. C. M. B. Cadwalader, Managing Director of the Academy, have given much of their time to raising funds for its publication. The staff of the Academy, particularly Mr. E. G. Vannatta, have kindly given me assistance on many occasions and I wish to offer my thanks to them.

Professor H. Burrington Baker, of the University of Pennsylvania and Research Associate at the Academy has helped me in many ways. The illustrations have been provided for by the Academy and are based on photographs taken by Miss Helen Winchester and in many cases, retouched by her under my direction.

Through Prof. B. L. Clark, I am indebted to the Museum of Paleontology of the University of California for financial assistance received during the early part of this work, and particularly for the opportunity to borrow much of the Museum's collection of the original material of the Geological Survey of California, in which some of the original type specimens have been found.

Through the former Director, Dr. Samuel Henshaw, and Prof. Percy E. Raymond, the Museum of Comparative Zoölogy of Harvard University has sent me much of Whitney's collection of California fossils which contains some types. The opportunity to illustrate them in this paper is much appreciated.

To Professor E. W. Berry of Johns Hopkins University, where part of this work was done, I am indebted for much advice and encouragement, and I also wish to thank Prof. Berry for the interest he has taken in this work. His kindness in bringing this work to the attention of the Committee on Grants of the Marsh Fund, I particularly wish to record. All the members of the Faculty of the Department of Geology at Johns Hopkins University have afforded me numerous courtesies and privileges which are closely connected with this work and which have aided in its completion. Among the graduate students of that institution, I have found many friends who have helped me and whose friendships I naturally associate with this work.

This work has been supported by three grants from the Marsh Fund of the National Academy of Sciences, the third toward the cost of publication. My thanks are due particularly to the Committee on Grants of the Marsh Fund,* whose chairman, Dr. John C. Merriam has done so much toward unravelling the complex geologic history of California.

For the opportunity to examine specimens in the National Museum I am indebted to the late William Healy Dall and to Dr. Paul Bartsch, Curator of Mollusca, and to Dr. T. W. Stanton and Dr. John B. Reeside, Jr. Dr. C. W. Cooke has kindly shown me the Museum's collections of Early Tertiary Mollusca, part of which he has himself collected. Miss Julia Gardner, Dr. W. C. Mansfield and Dr. James Gilluly have also helped me in Washington, and I have also enjoyed there the hospitality of Dr. and Mrs. Wendell P. Woodring. Dr. Woodring has given much of his time to helping me with specimens in the National Museum, while his knowledge of Later Tertiary Mollusca has been most stimulating and the

source of many interesting discussions from which I have greatly benefited. Additional acknowledgments for specific assistance have been recorded in the text. It has not been practical to acknowledge all the references and dates I owe to the work of Dr. C. Davies Sherborn, and I therefore wish to record here my indebtedness to and appreciation of his great "Index Animalium." For his help and interest in this work, I wish to thank Dr. Alfred Woodford of Claremont College, California. Dr. Isabel C. Stewart, my sister, has given much of her time to working on the manuscript and I am greatly indebted to her. I also wish to acknowledge the interest and financial assistance of my father, Mr. Ethan E. Stewart, of Seattle.

III. SOURCES OF MATERIAL

The majority of the types have been found in the Academy's collection and are referred to by its catalogue numbers. Specimens from the Museum of Paleontology of the University of California are indicated as from the Museum of Paleontology, and those from the Museum of Comparative Zoölogy of Harvard University are so designated. Specimens not otherwise indicated are from the Academy's collections.

The following types have been found in the collection from the Museum of Paleontology:

<i>Agnomyx monilifer</i> (described as	" <i>Meretrix</i> " <i>longa</i>
<i>Tellina</i>)	<i>Mytilus?</i> <i>pauperculus</i>
" <i>Anatina</i> " <i>lata</i>	<i>Ostrea breweri</i>
" <i>Anomia lineata</i> "	<i>Panopaea?</i> <i>concentrica</i>
" <i>Arca</i> " <i>decurta</i>	<i>Pecten cerrosensis</i> (not examined)
" <i>Arca</i> " <i>gravida</i>	<i>Pecten veatchii</i> (not examined)
<i>Clementia pertenuis</i> (described as	<i>Pholadomya breweri</i>
<i>Venus</i> , not examined)	<i>Pinna breweri</i>
<i>Crassatella grandis</i> = <i>C. uvasana</i>	<i>Syncyclonema operculiformis</i> (de-
<i>Crassatella tuscana</i>	scribed as <i>Pecten</i>)
" <i>Crenella</i> " <i>concentrica</i>	" <i>Tellina</i> " <i>decurtata</i>
<i>Diodus tenuis</i>	" <i>Tellina</i> " <i>ooides</i>
" <i>Dosinia</i> " <i>inflata</i>	" <i>Tellina</i> " <i>rémondii</i>
<i>Lima appressa</i>	<i>Trigonia tryoniana</i>
" <i>Limopsis</i> " <i>transversa</i>	<i>Turnus plenus</i>
<i>Lithophagus oviformis</i>	" <i>Venus</i> " <i>veatchii</i>
<i>Martesia clausa</i>	<i>Yoldia cooperi</i> (a Recent specimen,
<i>Meekia sella</i>	not examined)
" <i>Meekia</i> " <i>navis</i>	
" <i>Meretrix ovalis</i> " = <i>Cycinella ele-</i>	
<i>vata</i>	

Some of these specimens were recognized by Merriam (1895), who also found the following, which though I have not seen them, will probably all be rediscovered in the Museum's collections:

<i>"Avicula" pellucida</i>	<i>Mytilus ascia</i>
<i>Arca sulcicosta</i>	<i>Ostrea atwoodii</i>
<i>"Chione" whitneyi</i>	<i>Ostrea tayloriana</i>
<i>Cardiomya dolabraeformis</i>	? <i>Tapes truncata</i>
<i>Corbula cultriformis</i>	<i>Trigonia leana</i>
<i>Gari alata</i>	<i>Unio penultimus</i> (doubtful)
<i>Lucina cumulata</i>	
<i>Miltha gyrata</i> (as <i>Dosinia</i>)—recognized by Clark and Woodford	

The Museum also has some of the original specimens of other species which may later be designated as types.

Type specimens or original material for the following species have been found in the collection from the Museum of Comparative Zoölogy of Harvard University and are figured in this paper:

<i>Agnomyax monilifer</i> (described as <i>Tellina</i>)	<i>Pelecypora aequilateralis</i> (described as <i>Venus</i>)
<i>Anomia vancouverensis</i>	<i>Periplomya? quadrata</i>
<i>Donax latus</i>	<i>Pitar barbarensis</i>
<i>Gari edentula</i>	<i>Saxidomus gibbosus</i> = <i>Venerella subdiaphana</i> (Carpenter)
<i>Inoceramus whitneyi</i>	<i>Spisula polynyma voyi</i> (described as <i>Mactra</i>)
<i>"Leda" alaeformis</i>	<i>Tellina longa</i>
<i>Lima multiradiata</i>	<i>Thyasira disjuncta</i> (described as <i>Conchocele</i>)
<i>Mioconcha major</i>	<i>Trapezium carinatum</i>
<i>Ostrea appressa</i>	<i>Trigonia aequicostata</i>
<i>Ostrea idriaensis</i>	
<i>Palliolum peckhami</i> (described as <i>Pecten</i>)	
<i>Pecten martinezensis</i>	

No trace has been found of the original material of the following species:

<i>Arcomya undulata</i>	<i>Pecten traskii</i>
<i>Corbula primorsa</i>	<i>Septifer dichotomus</i>
<i>Dosinia conradi</i>	<i>Solen diegoensis</i>
<i>Lima microtis</i>	<i>Tapes? cretacea</i>
<i>Lucina? cretacea</i>	<i>Tellina ashburnerii</i>
<i>Lucina postradiata</i>	<i>Tellina californica</i>
<i>Meleagrina antiqua</i>	<i>Tellina? quadrata</i>
<i>Nucula solitaria</i>	<i>Unio hubbardi</i>
<i>Pecten californicus</i>	<i>Yoldia nasuta</i>
<i>Pecten complexicosta</i>	<i>Zirphaea dentata</i>

IV. CRETACEOUS

The following species were described from the Cretaceous deposits near Martinez:

<i>Anthonya cultriformis</i>	<i>Aphrodina varians</i>
<i>Aphrodina nitida</i>	<i>"Chione" angulata</i>

<i>Corbula parilis</i>	<i>Protocardia translucida</i>
" <i>Crenella</i> " <i>concentrica</i>	" <i>Solen</i> " <i>cuneatus</i>
<i>Cucullaea truncata</i>	" <i>Tellina</i> " <i>aequalis</i>
" <i>Mactra</i> " <i>tenuissima</i>	" <i>Tellina</i> " <i>mathewsonii</i>
<i>Meekia sella</i>	" <i>Tellina</i> " <i>ooides</i>
" <i>Meretrix</i> " <i>fragilis</i>	" <i>Tellina</i> " <i>parilis</i>
<i>Mytilus?</i> <i>quadratus</i>	<i>Thetironia annulata</i>
<i>Pachycardium?</i> <i>remondianum</i>	<i>Trigonia aequicostata</i> (in part)
<i>Periplomya tryoniana</i>	" <i>Venus</i> " <i>tetrahedra</i>
<i>Pharella alta</i>	

Most of the specimens from the Cretaceous of Martinez, including the gastropods, are in a dark, gray to black, limy sandstone and are covered, more or less, with a reddish brown stain. The sandstone also contains many fragments of large shells. *Aphrodina nitida*, "*Venus*" *tetrahedra*, *Anchura?* *angulata*, *Solariella angulata*, and *Avellana mathewsonii* are in a fresh dark limy sandstone, full of shell fragments, and retain their lustre. Possibly these specimens are from a less weathered portion of the same strata that contained the stained specimens. *Epitonium mathewsonii*, *Anthonya cultriformis*, *Thetironia annulata*, "*Tellina*" *parilis*, and "*Corbula*" *parilis* have likewise retained their lustre and are in a similar matrix except that it contains black angular fragments—reaching a length of at least 6 mm.—of what I have supposed to be carbonaceous material, and some less angular, and for the most part small, quartz pebbles. Shell fragments are not so common in this rock. Small pebbles occur in the sediments of the stained specimens, sporadically,—particularly in the matrix of the right valve of *Meekia sella* figured in this paper and in that of the specimen figured as "*Tellina*" *mathewsonii*, which contains a layer of small pebbles—mostly under 5 mm. in diameter—of various colors and textures, including chert and quartz.

While the striking differences in the preservation of some of the fossils indicates that more than one stratum and perhaps more than one locality is included under the general name "Martinez," there appears no serious reason for not accepting this fauna in general as homogeneous.

The presence of the genus *Thetironia* suggests that this fauna is Céno-manien or earlier.

In the matrix of a specimen of *Aphrodina nitida*, containing also a specimen of "*Venus*" *tetrahedra*, is a gastropod which may be *Perissolax? occidentalis*, thus suggesting that that species was from the Cretaceous at Martinez, rather than from the Paleocene.

In the aperture of the holotype of *Tessarolax? inconspicua* and the peculiar specimen of *Conchothyra hamula* figured by Gabb in 1869 (pl. 27, fig. 42) a micaceous quartz grit is preserved which is unlike any of the rocks from Martinez in the collections. These specimens may represent

another type of deposition in the Cretaceous of Martinez, but the sediments have a remarkable resemblance to a grit from Cottonwood Creek in which specimens of *Parallelodon brewerianus* and *Plicatula variata* are preserved. So little of the matrix of *Tessarolax? inconspicua* is preserved that it cannot be positively stated that it is the same as that of the peculiar specimen of *Conchothyra hamula*, but what little evidence there is points to a Cretaceous age for *Tessarolax? inconspicua*.

Martinez may eventually be fixed as the type locality of *Trigonia leana*, and "*Corbula*" *cultriformis*—though the type specimen has not yet been established—is also from this locality.

The following species were described from Penz:

<i>Acila demessa</i>	<i>Martesia clausa</i>
" <i>Anatina</i> " <i>lata</i>	? " <i>Meekia</i> " <i>navis</i>
" <i>Anomia lineata</i> "	<i>Pholadomya brewerii</i>
<i>Crassatella tuscana</i>	" <i>Tellina</i> " <i>decurtata</i>
" <i>Lutraria</i> " <i>truncata</i>	<i>Volsella telea</i>

The unquestioned species, with the exception of *Acila demessa* which is free from any sediments, are in a soft, weathered, gray, sandstone, full of shell fragments. *Potamides tenuis* is also from this sandstone. "*Meekia*" *navis* is in a harder sandstone. Its locality is discussed under *Meekia sella*. *Tellina ashburnerii*, the original material of which has not been found, was also described from this locality.

The following species were described from Texas Flat:

<i>Agnomyax monilifer</i>	• " <i>Meretrix</i> " <i>longa</i>
<i>Clisocolus dubius</i>	<i>Myrtaea? gabbi</i>
<i>Crassatella conradiana</i>	<i>Protocardia placerensis</i>
<i>Cymbophora ashburnerii</i>	<i>Rhynchomyx undulatus</i>
<i>Limopsis transversa</i>	<i>Trapezium carinatum</i>

All of these species are small specimens—the largest is "*Meretrix*" *longa*—and have a similar type of preservation in a soft yellow sandstone. All the gastropod types listed from this locality (Stewart, 1927, p. 293) are also small and have a similar type of preservation, with the possible exception of "*Patella*" *traski*, which is not available at the present time. *Lucina postradiata*, *Nucula solitaria*, and *Pecten traski* were also described from Texas Flat, but none of the original material has been found. The presence of the genus *Protocardia* suggests that this fauna may be as old as the Cénomanien, instead of the Upper Cretaceous age usually assigned to it.

The holotype of "*Dosinia*" *inflata* and the Academy's specimens of *Flaventia? lens* from Chico Creek are in a fine, dark gray, limy sandstone full of shell fragments. The matrix of the lectotype of *Anchura falci-*

formis is also very similar to this sandstone and is better called a fine sandstone than a shale. The probability that the lectotype of *Anchura falciformis* was from Chico Creek is increased and now practically amounts to certainty. The specimens are labelled Chico Creek and Tuscan Springs but none of Gabb's species from Tuscan Springs have this type of preservation, while on the other hand, it is possible to identify two of Gabb's specimens of *A. falciformis*, with the lectotype, as being from Tuscan Springs. Both specimens are comparable to *A. falciformis* but neither is sufficiently well preserved to permit unqualified identification. The matrix of *Turritella chicoensis* is probably the weathered product of the fine sandstone.

Four species of lamellibranchs were described from Tuscan Springs, *Glycymeris veatchii*, *Trigonia tryoniana*, *Venus veatchii* and also *Tellina? quadrata*, the original material of which has not been found. Like the gastropods from this locality, the first three of these species are preserved in a coarse grit or fine conglomerate containing fragments of weathered chert, some of which are more than 20 mm. long. The matrix of the lectotype of *Glycymeris veatchii* contains two large fragments of unweathered chert. All Gabb's species from Tuscan Springs probably came from this fine conglomerate, including *Oligoptycha obliqua*, whose coarse sandstone matrix may be better termed a gift.

The following species are from Cottonwood Creek, Shasta County:

<i>Lima shastaensis</i>	<i>Pleuromya papyracea</i>
<i>Neithea grandicosta</i>	" <i>Thetis</i> " <i>elongata</i>
<i>Panopea? concentrica</i>	<i>Turnus plenus</i>
<i>Parallelodon brewerianus</i>	

Lima microtus and *Pecten californicus* were also described from this locality but the original material has not been found.

Lima shastaensis and *Neithea grandicosta* are preserved in a weathered, dark, micaceous, shaly sandstone, containing some black angular fragments, and are presumably from the same stratum. Neither of these species was listed in Diller and Stanton's study of the Cottonwood section (Geol. Soc. Amer. v. 5, 1893, p. 442-446) and this particular stratum or locality was evidently not found by them. The lectotype of *Parallelodon brewerianus* is in a dark blue, sandy shale, but it also occurs in a coarse, micaceous grit similar to that surrounding a specimen of *Plicatula variata*, a species originally described from Battle Creek. Both of these species were listed from the lower part of the section on the North Fork of Cottonwood Creek by Diller and Stanton, and *Parallelodon brewerianus* (as *Nemodon Vancouverensis*) was also listed from near the middle of the section in beds referred by them to the Chico. This species is the type of a new subgenus *Nanonavis* whose European distribution suggests that it is indicative of Cénomanien or earlier horizons.

Pleuromya papyracea is preserved in a dark sandy shale, and the matrix of the holotype of *Panopea? concentrica* may be a weathered product of that shale but the evidence is not strong. Neither of these species was listed by Diller and Stanton from the North Fork of Cottonwood Creek. "*Thetis*" *elongata* is likewise absent from their lists and it is therefore likely that most of Gabb's Cottonwood Creek material did not come from the North Fork. *Turnus plenus*, however, is in a shale matrix, and the species was listed by Diller and Stanton from the uppermost shales of the section classed as Horsetown by them.

Most, if not all of the gastropod types from this region, are in sandy shales of various hardness and color from which I am unable to gain any idea of their possible associations.

The specimen of *Pinna brewerii* figured in this paper is labelled "Cottonwood Creek" and is in a black limy sandstone full of shell fragments and carbonaceous material. The locality of the holotype is unknown. The Academy's specimen of *Syncyclonema operculiformis* (4391) is preserved in a similar black sandstone containing a large amount of carbonaceous material, and was probably from the same locality. The matrix of the lectotype is also a black limy sandstone possibly from this region. *Pinna brewerii* is absent from Diller and Stanton's lists, while *S. operculiformis* is listed in five different strata from the section on the North Fork of Cottonwood Creek, including both their Horsetown and Chico divisions.

The neotype of "*Ostrea*" *malleiformis* is preserved in a hard, dark gray, micaceous limy sandstone from Cottonwood Creek, Siskiyou County, and is very similar to the matrix of the figured examples of *Pugnellus manubriatus*, also from that locality (Stewart, 1927, p. 358, pl. 20, figs. 10-12).

Ostrea brewerii and *Lithophagus oviformis* are from a weathered, light gray, rather coarse sandstone from Cow Creek, Shasta County, and *Lembulus? translucidus*, which is also from this locality, is preserved in a black limy sandstone which may be a fresh example of the weathered gray sandstone. *Plectocion curvirostris*, which is also from Cow Creek, is preserved in a finer, light gray, limy sandstone, while very little of the matrix of "*Ringicula*" *varia* has been preserved.

The following types were from the Siskiyou Mts:

<i>"Dosinia" pertenuis</i>	<i>Pholadomya oregonensis</i>
<i>Periplomya inaequilateralis</i>	<i>"Siliqua" oregonensis</i>
<i>Periplomya? whitneyi</i>	<i>Volsella siskiyouensis</i>

All of these species, with the exception of the first, are brown-stained internal casts in a soft, much weathered, brown micaceous sandstone. They are so similar that it is practically certain that they came from the

same locality, though they were cited as coming from the summit of the Siskiyou Mountains, north side of the Siskiyou Mts. and Jacksonville, Oregon. Most of the shell of the holotype of "*Dosinia*" *pertenuis* is preserved and the matrix is a hard, dark, limy, micaceous sandstone, probably an unweathered example of the soft brown sandstone. It seems highly probable that all these species were from Whitney, and were collected "from the north side of the Siskiyou Mountains, Oregon, near the Toll House, on the stage road" (Gabb, 1864, p. 147).

The lectotype of *Buchia crassa* has a limy shale matrix and is probably from Calusa County. The figured specimen of *Myoconcha major* is in a limestone matrix also from Calusa County, and the figured specimen of *Buchia piochii* has a limy shale matrix and is also probably from Calusa County, though the original locality, as restricted by Gabb, is the region around Mt. Diablo. Of the five gastropods described by Gabb from south of Calusa (Stewart, 1927, p. 295), the matrix of only one, *Acteon politus* is now available and it is quite different from that of the lamellibranchs, being a black limy sandstone. In view of Gabb's statements regarding the material figured as the lectotype of *A. politus*, it seems more correct to call that specimen a neotype, rather than a lectotype (Stewart, 1927, p. 431, pl. 24, fig. 18).

Linearia multicostata is from the Crooked Creek on the Deschutes River, Oregon, in a sandstone very similar to, but less weathered than that containing the large casts of *Trigonia* cf. *evansii*.

"*Arca*" *decurtata* and "*A.*" *gravid*a from Rag Canyon are preserved in a conglomerate, probably the one mentioned by Whitney on Puta Creek—now Putah Creek, Napa County.

Lima appressa is from the San Luis Gonzaga Ranch at the east end of Pacheco's Pass in a conglomerate, which is the same as the matrix of the figured specimen of *Gyrodes conradiana* (Stewart, 1927, p. 329, pl. 22, fig. 2).

Of the two species described from Folsom, *Inoceramus whitneyi* is in a soft, gray, shaly sandstone, and what little remains of the matrix of *Exogyra parasitica* is a soft, brown sandstone. From the Cretaceous of Vancouver Island, *Periplomya*? *quadrata* and *Anomia vancouverensis* were described. They are both in a similar matrix, a rather, soft, dark green, shaly sandstone, containing some fragments of what I suppose to be volcanic glass. This is evidently the greenish rock which Gabb found "on the north shore of Departure Bay, near Nanaimo, Vancouver Island" (Gabb, 1869, p. 198). The original material of "*Meleagrina*" *antiqua* and *Unio hubbardi*, which were also described from Vancouver Island, has not been found.

The resemblance of some of the Cretaceous species with European Cretaceous species is indicated under each species. No general correlation

with the European time scale is attempted however, because the range of the species throughout the Cretaceous of California has not been well established and is unknown to me. None of the species studied seems to require a greater age than Lower Cretaceous-Néocomien.

V. Eocene (Subalpinian)

A two fold classification of the Tertiary deposits of Europe was proposed by Bronn in 1831 (*Italiens Tertiär-Gebilde und deren organische Einschlüsse*, Heidelberg, 1831, p. 1-176, p. 169-170). On the basis of the percentage of living species Bronn divided the Tertiary into "Aeltere Schichten" having only 4% living species—and most of them living in foreign seas—and "Jüngere Schichten" having 40% of living species. He recognized the Parisian and English Tertiaries as the older and the Bordeaux deposits as the younger. The older he called the "Subalpinische Formation" and the younger the "Subapenninische Formation." These two names which may be translated to Subalpinian and Subapenninian are much earlier than such names as Neogene, Paleogene, Nummulitique and Eocene, now in use for the two divisions of the Tertiary. These names are actually earlier than Lyell's terms, Eocene, Miocene and Pliocene, which appeared in the third volume of his "Principles of Geology" in 1833. Bronn's work was evidently independent of that of Deshayes, a résumé of which had appeared in 1831 under the title "Tableau comparatif des espèces de coquilles vivantes avec les espèces de coquilles fossiles des terrains tertiaires de l'Europe, et des espèces de coquilles de ces terrains entr'eux" (*Soc. Géol. Fr. Bul.* 1, 1831, p. 185-189.) Deshayes divided the Tertiary into three epochs on the basis of the percentage of living species, and it was these three epochs which Lyell named. Bronn apparently gave up his arrangement for that of Deshayes, and his two names have not been used.

Paleocene. Only six species are from the Martinez formation near Martinez and two of them are doubtful:

?, "*Cardita*" *veneriformis*
Crassatella compacta
Cucullaea mathewsoni

?, *Pecten martinezensis*
Pholadomya nasuta
 "*Tellina*" *undulifera*

It is remarkable that of these six species, two of them, *Cucullaea mathewsoni* and "*Tellina*" *undulifera* should represent genera which are not known above the Paleocene in California, though they are common in the Paleocene of both Martinez and Simi Valley. Both of these species are preserved in a dark blue, shaly sandstone and what remains of the matrix of *Pholadomya nasuta* suggests that it was from a similar rock. *Priscoficus caudata* has a similar matrix and that of *Mesalia martinezensis* and "*Neptunea*" *cretacea* may be the weathered product of this rock.

Crassatella compacta has a lustrous preservation and matrix so similar to specimens of *Brachysphingus sinuatus* that it is probable that they were from the same boulder. The preservation of the lectotype of *B. sinuatus* itself is also sufficiently similar to warrant the belief that the different specimens were all from the same stratum. The Tertiary age of these two species is rather firmly established. Perhaps the best evidence is the resemblance of *Brachysphingus sinuatus* to *B. gibbosus* Nelson from the Paleocene of Simi. These two species of *Brachysphingus* may even be identical, for it is possible that Nelson was comparing his species with something other than *B. sinuatus*, perhaps the species which as since been described as *B. mammilatus* (Clark and Woodford, Univ. Cal. Bull. Geol. v. 17, 1927, p. 116, pl. 20, fig. 8-15; Meganos formation). *Crassatella compacta* seems to be present in the Paleocene at Simi where it has been called "*Crassatellites branneri*." Apparently Gabb had no other specimens from this fine, hard, gray, limy sandstone.

The horizon of "*Cardita*" *veneriformis* as well as that of "*Anchura*" *carinifera* is doubtful. A specimen, now with the holotype of "*Cardita*" *veneriformis* and probably conspecific with it, is in a coarse, dark gray, limy sandstone, having some black angular fragments. It may well be Cretaceous, but the rock which is not fresh has a greenish tint and fragments of small shells scattered through it. Except the holotype of "*Anchura*" *carinifera*, which is preserved in apparently similar rock, none of the other specimens from Martinez has a similar matrix. However, Dickerson has identified specimens occurring with *Cucullaea mathewsonii* as *Cardita veneriformis* and, should his determination prove to be correct, there would be no doubt that this species should be referred to the Martinez horizon in the Lower Tertiary—Paleocene of this paper.

The horizon of *Pecten martinezensis* is doubtful. The matrix of the lectotype is so decomposed that it is of little importance, but if it is the decomposed product of a fresh, black, limy sandstone which is preserved with the lectotype, it was probably from the Paleocene near Martinez. This fragment of fresh black sandstone also contains a poorly preserved small *Pecten*, which may be *Pecten martinezensis*. This sandstone is apparently identical with one containing a specimen comparable to *Retipirula crassitesta*. The lectotype of *R. crassitesta* has a sandstone matrix which may be the weathered product of the black sandstone and *Brachysphingus gabbi*, *Drepanochilus exilus*, *Heteroderma trachioidea*, *Lacunaria striata* and *Sycum mucronatum* were probably also from this sandstone. The small amount of rock preserved in the aperture of the holotype of *Areodactylus? costatus* also suggests that that species was from this sandstone. Both Merriam and Anderson recognized *Pecten martinezensis* in Cretaceous deposits near Martinez and their discoveries may counterbalance the circum-

stantial evidence here given for the Paleocene age of this species. Two specimens of *Lacunaria striata* are preserved in a black limy sandstone containing angular black fragments similar to those found in the Cretaceous sediments but the two sandstones are not identical.

"*Leda*" *alaeformis* and *Lima multiradiata* from Lake County are probably Paleocene species. They are both preserved in a hard, gray, limy sandstone full of shell fragments and may have come from the same boulder.

Eocene. Original material or type specimens of the following species are from Tejón:

<i>Corbula hornii</i>	<i>Halonanus hornii</i>
<i>Crassatella uvasana</i> ("C. grandis")	<i>Microcallista? conradiana</i>
<i>Cyclinella elevata</i> (and "Meretrix ovalis")	"Meretrix" <i>hornii</i>
<i>Gari hornii</i>	"Meretrix" <i>uvasana</i>
<i>Glycymeris sagittata</i>	<i>Plagiocardium brewerii</i>
	<i>Venericardia hornii</i>

Of these species, *Microcallista? conradiana* is perhaps the most interesting, for, though common at Tejón, the typical form has not yet been recognized elsewhere.

Septifer dichotomus, *Mytilus ascia* and "*Lucina*" *cumulata*, the original material of which has not been examined, are also from Tejón. A specimen of *Septifer dichotomus* from Tejón has been figured by Anderson and Hanna (Cal. Ac. Sci. Occas. Pap. v. 11, 1925, p. 187, pl. 1, fig. 2) and the last species has also been figured from Tejón by Dickerson (Cal. Ac. Sci. Pr. (4) v. 5, 1915, pl. 2, fig. 4—loc. 244, *fide* Anderson and Hanna, *op. cit.* p. 171).

Of the 42 species of lamellibranchs listed as valid from Tejón by Anderson and Hanna (*op. cit.* p. 42, 43), all but four of them were originally described from the region. *Acila gabbiana* was originally described from Eocene beds beneath the restricted Domengine formation north of Coalinga. "*Brachydontes ornatus*" being a homonym, has been supplanted by *Brachydontes cowlitzensis?* from the Cowlitz formation of Washington. The type locality of *Pteria pellucida* has not yet been established while the fourth species *Spondylus carlosensis*, originally described from the Avenal Sands, was admittedly identified specifically on insufficient evidence. *Brachydontes cowlitzensis?* (Weaver and Palmer), *Saccella gabbi* (Gabb), *Solen* (*Eosolen*) cf. *columbiana* (Weaver and Palmer) and *Tellina* cf. *longa* Gabb should be added to the list of valid names for Tejón lamellibranchs, and "*Brachydontes ornatus*," "*Leda vogdesi*," "*Solen novacula*," and "*Tellina castacana*" should be suppressed as synonyms or homonyms. *Glycymeris perrini* Dickerson should also be added to the list with the qualification that it may be a synonym of *G. ruckmani*. About one half of the generic names of the 42 species will have to be changed.

The Domengine Horizon. Type specimens or original material are from the Eocene at Martinez—the Domengine horizon:

<i>Cardiomya dolabraeformis</i>	<i>Modiolus ornatus</i> = <i>Brachidontes</i>
<i>Cardium cooperi</i> = <i>Nemocardium lin-</i>	<i>cowlitzensis</i> ?
<i>teum</i>	?, " <i>Mysia</i> " <i>polita</i>
<i>Crassatella uvasana mathewsonii</i>	?, <i>Pitar quadratus</i>
<i>Gari texta</i>	<i>Saccella gabbi</i>
<i>Glycymeris cor</i> = <i>G. perrini</i>	" <i>Solen</i> " <i>parallelus</i>
<i>Miltha gyrata</i>	<i>Tellina longa</i>

Of these species, *Cardiomya dolabraeformis* and *Miltha gyrata* may prove to be guide fossils for this horizon.

All but three of these species have a light gray sandstone matrix containing relatively few shell fragments and are probably from the same stratum. Except that it is darker and contains more shell fragments, *Tellina longa* and *Brachidontes cowlitzensis*? are preserved in a similar sandstone, and the little that remains of the matrix of "*Mysia*" *polita* suggests that it too was from this dark, rather hard sandstone, full of shell fragments. All the gastropods from the Domengine horizon at Martinez are associated with the light gray sandstone, except *Niso polita*, *Perissolax blakei* subsp., and *Molopophorus antiquatus*. The first two are preserved in a similar sandstone except that it is full of shell fragments. The matrix of *Perissolax blakei* subsp., is darker and contains a rather rounded fragment of shale 14 mm. long and is probably the same as that of "*Mysia*" *polita*. The matrix of *Niso polita* has a bluish-gray color and may be an unweathered specimen of the darker brown sandstone containing *Perissolax blakei* subsp. The sandstone in the aperture of *Molopophorus antiquatus* is dark brown, but may be the light gray sandstone stained. So little of the matrix of *Discinisca? circularis* is preserved that I am unable to discover even a suggestion of its possible horizon.

By some unfortunate error, "*Cerithiopsis alternata*" = *Cerithium dumblei*, *Molopophorus antiquatus*, *M. cretaceus* and *Niso polita*, were not included in the list of types from the Domengine horizon at Martinez, published in the paper dealing with the gastropods (Stewart, 1927, p. 300) as they should have been. The possibility that *Pleurofuscia raricostata* and *Scobinella claytonensis* may have come from Martinez should also be kept in mind. They are preserved in what appears to be the light gray sandstone of Martinez. It is perhaps necessary to add that the two figured specimens of *Pleurofuscia raricostata* are probably not conspecific.

From the Eocene in the region known as North of Mt. Diablo, there is the specimen presumed to be the holotype of "*Tellina*" *remondii*. This specimen, stained dark brown, and poorly preserved, is in a coarse greenish

gray and brown sandstone from Cochran's. *Unio penultimus* of which the original material has not yet been found, is also from this region as well as *Lucina? cretacea*, and part of the original material of "*Tellina*" *californica*. A specimen of *Lucina? cretacea* from Marsh's Ranch has been figured by Clark and Woodford (Univ. Cal. Bull. Geol. v. 17, 1927, p. 92, pl. 15, fig. 7—as *Diplodonta*).

Types of the following species are from the vicinity of New Idria, from strata presumably of the Domengine horizon: *Donax latus*, *Ostrea idriaensis*, *Propeamusium interradiatum*.

The matrix of *Donax latus* is a coarse, gray sandstone, containing a specimen of *Ostrea idriaensis* and very similar to the matrix of the lectotype of *Loxotrema turritum*. It seems likely that all three species were from the same stratum. Since Gabb called the Academy's material of *Loxotrema turritum* "dupl. type" the specimen which I designated the lectotype should be termed a neotype. *Donax latus* and *Ostrea idriaensis* are also known from the Domengine horizon at San Diego, while none of these species has been found at Tejón. *Propeamusium interradiatum* is in a different matrix, but it may well be of the Domengine horizon.

San Diego is the type locality for *Barbatia morsei*, *Pelecypora aequilateralis* and "*Solen*" *diegoensis*. Original material of the last species has not been found. The matrix of *P. aequilateralis* is coarser than that of *Barbatia morsei* and they are presumably from different strata.

"*Placunanomia*" *inornata* was described from Corral Hollow and from San Diego. The specimen figured in this paper is from Corral Hollow. Corral Hollow, south of Mt. Diablo, is the type locality of *Diodus tenuis*, the age of which is unknown, but which is presumably Tertiary. Two more species, *Corbula primorsa* and *Tapes? cretacea* were described from this region but the original material of neither has been studied.

From a recent paper on the Domengine horizon (Clark, Univ. Cal. Bull. Geol. v. 16, 1926, p. 99) it appears that at the present time the most important stratigraphic evidence for the superposition of the Tejón formation on the Domengine horizon is found in outcrops of Eocene strata at the south end of the San Joaquín Valley in San Emigdio Creek and eastward to Tejón. Near the contact of the Tertiary strata and the crystalline complex on the eastern ridge of the San Emigdio Canyon, a small fauna has been collected which is suggestive of the Domengine horizon. An unconformity which is said to overlie this fauna has been recognized by Clark near the base of the eastern wall of the Canyon not far above the crystalline complex. This supposed "angular unconformity" has been illustrated by Clark (Jour. Geol. v. 29, 1921, p. 150, fig. 6), and while it may be an unconformity, in view of the importance of this locality, it is regrettable that the evidence is not more conclusive. Judging from the photograph and diagram published by Clark, one might be justified in suspecting that a

slight slip of the strata had given rise to this supposed unconformity. Examination of the outcrop itself does not convince one that a true stratigraphic unconformity is exposed there. During a visit to this locality in the company of Professor Clark, I came to the conclusion that the unconformity can be more simply explained as a slipping of lenticular strata down the steep slope of the outcrop. There may also have been some differential movement of the lenses of sandstone at the time these strata were tilted to their present attitude. This "unconformity" is mapped as extending eastward across Pleito Creek, Salt Creek, Tecuya Creek, to the east side of Grapevine Creek. The terrain along this line is in many places covered with brush and soil, difficult to traverse, and largely of unfossiliferous sandstone in numerous lenses, as would be expected from its proximity to the crystalline complex. Considering the few exposures of strata and their deformation, and the few fossil localities, it may be doubted whether even a transit survey over this terrain could definitely establish the synchronicity of these lenticular strata over the fifteen-mile interval. Unfortunately, the shales overlying the "unconformity" on San Emigdio Creek have not yet yielded a satisfactory Tejón fauna.

When the Tejón and Domengine faunas have been found in the same stratigraphic column, it will then be possible to more definitely interpret the relationship of the Domengine horizon at San Emigdio to the type Tejón. Clark's interpretation of the stratigraphy of that region is not entirely unreasonable and may be the correct one—with the exception of the "angular unconformity"—but it was made at a time when he thought that the Coalinga, Mt. Diablo, and Simi Valley Eocene sections showed conclusively that the Domengine—then called Meganos—horizon was stratigraphically beneath the Tejón formation or "Group." Since the Tejón at Coalinga is now called Domengine, and the evidence for Tejón strata at Mt. Diablo and Simi Valley is not conclusive, the interpretation of the San Emigdio-Tejón section is no longer unquestionable. Strata of Eocene age overlie the Domengine horizon in the sections on the south side of Mt. Diablo, on the south side of Simi Valley and possibly at Coalinga and San Diego and these strata may be of Tejón age, but in each locality, the known faunas are too small and too poorly preserved to be definitely determined as Tejón. There seems to be no stratigraphic evidence against placing the Tejón above the Domengine horizon and some supporting such an arrangement. However, it seems fair to state that if a section were found in which the Domengine fauna overlaid the Tejón, it could not be claimed, at this time, that such a section, because of the superposition of the Domengine fauna, was overturned.

It is not yet possible to definitely correlate the Domengine and Tejón faunas with the established Eocene faunal successions in Alabama and

therefore the fossils themselves offer little evidence on the relative age of the two faunas. Assuming that *Venericardia aragonia* is a guide fossil of the Domengine horizon, the close resemblance of this species to *V. horatiana* of Alabama suggests the correlation of the Domengine horizon with the Upper Wilcox and St. Maurice stages. It might well be that the Tejón is then to be correlated with the Claiborne but the evidence does not appear conclusive. The genera *Strepsidura* and *Perissolax* both are apparently only known from the Wilcox group in Alabama but both of these genera are present at Tejón. *Ficopsis remondii* is represented at Claiborne by the inflated type—*F. penita*. It would be interesting to know if the angular form occurs with it. *Ficopsis cooperiana*, which seems to be a guide fossil of the Domengine horizon, is apparently related to a Wilcox species. *Surculites mathewsonii*, a Domengine species and perhaps also occurring in the Santa Susana¹ formation resembles *S. engonatus* (Heilprin) (Harris, Bul. Am. Pal. v. 3, 1899, p. 47, pl. 6, fig. 4—as *Chrysodomus*) from the Wilcox and apparently Lower Claiborne of Texas, while the Tejón form *S. sinuatus*, which often developed a high collar, has not been noticed in the Gulf Eocene. *Pelecyora aequilateralis*, from the Domengine horizon at San Diego seems to be related to a Claiborne species. The Eocene *Cras-satella uvasana* may be more closely related to the California Paleocene *C. compacta* than to the Claiborne *C. alta*. No doubt other species of the Eocene (Tejón of earlier writers) fauna of California were developed from the Paleocene species of the same region.

The species of *Venericardia*, *Surculites* and *Ficopsis* suggest that the Tejón is to be correlated with the Claiborne and the Domengine with the Upper Wilcox or St. Maurice stage. However much more work must be done before this correlation can be accepted. In fact the Tejón and Domengine faunas seem so closely related that definite knowledge of their relative age may never be gained by comparing them to the Alabama faunas. Perhaps the Texan and Mexican sections will yield more definite information and then again perhaps the differences between the Domengine and Tejón faunas is not due to a lapse of time. Until more stratigraphic evidence has been found I think the time factor is not more than a reasonable assumption.

VI. NEOGENE (Subapenninian)

The San Ramón formation, or the *Agasoma gravidum* zone was placed in the Oligocene by Clark (Univ. Cal. Bull. Geol. v. 11, 1918, p. 45-234)

¹ The name "Santa Susana sandstones" was applied to sandstones in the Santa Susana Mts., but the term was not used for a geologic formation but rather as a commercial name (Jackson, Cal. Min. Bur. 7th An. Rep't, 1888, p. 208) and should not, I think, interfere with the present use of this name for Eocene shales in Simi Valley (Nelson, Univ. Cal. Bul. Geol. v. 15, 1925, p. 402).

because of the resemblance of its fauna to that of the San Lorenzo, and marked difference from the Vaqueros and Temblor faunas. Perhaps this difference has been exaggerated by separating species, on insufficient grounds, from their closely related Miocene relatives. Many of the new species described by Clark are poorly preserved and differences of opinion regarding them are inevitable. The *A. gravidum* zone was formerly called Miocene and, in reviewing Clark's work, Cossmann noticed the absence of Oligocene genera and suggested that the fauna was about the age of the Aquitanien (Revue Crit. Paléoz. v. 21, 1918, p. 77-79). *Exilia lincolnensis* and *Nemocardium lorenzanum* are two species which suggest the Oligocene. *Exilia lincolnensis* has been figured by Clark from near Coalinga (*ibid.*, p. 179, pl. 23, fig. 10) and was also said to occur in the San Ramón and San Lorenzo formations; unfortunately the San Ramón specimen has not been figured. *Nemocardium lorenzanum* was said to occur in the Kirker formation north of Mt. Diablo and rarely in the San Ramón formation (*ibid.* p. 141). If *Nemocardium* does occur in the San Ramón formation it would tend to suggest that the horizon was Eocene, but it would not be surprising to find *Nemocardium* surviving into the Neogene of California as it seems to have in Europe. The San Ramón fauna has been recognized in two places in California, in the region of the type locality and on San Emigdio Creek (Wagner and Schilling, Univ. Cal. Bull. Geol. v. 14, 1923, p. 239, 250) and in the first region the Vaqueros was not recognized. In the San Emigdio section the Vaqueros was not definitely recognized though it may be present. The upper part of the "San Lorenzo Group"—the Pleito formation—was correlated with the San Ramón formation and *Dosinia mathewsonii* was listed from 13 localities of this formation. *Dosinia mathewsonii* was also sighted from the underlying San Emigdio formation (p. 243) but no localities were given, and the species was not included in the faunal checklist for the San Emigdio formation (p. 244). It may be that *Dosinia* is absent from the San Emigdio formation and that the line between the Eocene and the Neogene in this section should be placed between the Pleito and the San Emigdio formations. It is generally accepted that the stratigraphic break between the San Emigdio and Pleito formations is not of much importance but the distribution of *Dosinia* in this section at least seems to deserve further investigation.

Until more evidence of Eocene genera has been found, I think the Oligocene age of the San Ramón formation unproved and therefore return to the earlier arrangement in calling it Miocene. A restudy of the San Ramón fauna will probably show that it is more closely related to the Vaqueros and Temblor faunas and therefore to be placed in the Miocene. The presence of the genus *Dosinia*, which is not known before the Miocene on the East Coast or Europe, suggests that the San Ramón formation is better called Miocene.

About 20 of the species of this report are from the Neogene. They come from numerous places in California and also Cedros Island and the age given for them is based upon the literature. There are so few from any one locality that a superficial study of their type of preservation has resulted in no generalities which seemed worth recording. Some note on the type of preservation and the stratigraphic horizon will be found under each species.

VII. COMPOSITION OF TERTIARY FAUNA

Tertiary lamellibranchs in the Northern Hemisphere—and gastropods also—may be divided into two main faunas, Eocene and Neogene. Although there is some overlapping of these two faunas it is difficult to find the direct ancestors of the dominant Neogene types in the Eocene. The Eocene genera which have survived into the Neogene are almost entirely restricted to low latitudes and those still living are confined to the warmer oceans. The difference between related species in the two faunas are, for the most part, generic, for most of the families, as now used may be confidently recognized in the Eocene.

New genera appear in the Paleocene, Eocene, Oligocene, and Miocene, and old genera disappear in each of these divisions. It is therefore possible that the break between the Eocene and the Neogene is overemphasized, due to the lack of knowledge of the Upper Oligocene fauna. Lack of published information on the American Atlantic Oligocene Mollusca has been recently emphasized by Professor Woodring in his great monograph on the Bowden gastropods (Carnegie Inst. Wash. Publ. 385, 1928, p. 26). Woodring listed 17 genera or subgenera, chiefly gastropods common to the Byram Marl (Upper Oligocene) and the Bowden Miocene. At least half of the forms listed are first known from the Byram, though in view of the lack of knowledge, they may yet turn up in earlier Oligocene deposits. Six of the forms listed are known from the Eocene and all those listed are now restricted to warm waters or are extinct. A study of the Byram fauna should give a slightly greater age for some of the genera which I have failed to find below the Miocene, particularly for those genera now living in warm waters, but it seems unlikely that forms connecting the dominant Eocene and Neogene genera will be found in the Byram. It is but natural to infer that more northern Oligocene horizons contained forerunners of the temperate Neogene genera but such forerunners have not been found in Europe, and a well preserved Oligocene fauna is not exposed on the northern shores of the Western Atlantic. While more of the Neogene genera will doubtless be traced to the Eocene it is not likely that they will be found to grade into the dominant Eocene forms or be in sufficient numbers to upset the dual nature of the Tertiary fauna. Perhaps the Neogene forms developed in the Arctic ocean and invaded the temperate zone during the Miocene.

This seems like a reasonable possibility though there is little direct evidence that such a development and migration occurred. More information on the origin of the Neogene fauna may come from the Oligocene of the North Pacific. If that region should contain forerunners of the Neogene fauna considerable difficulty might be experienced in distinguishing Upper Oligocene from Lower Miocene. However, Neogene genera from that region should be considered Neogene until their association with numerous Eocene genera makes it reasonably certain that they are older.

As a rough generalization it may be said that genera of lamellibranchs of the temperate regions can be traced to the Miocene, and subfamilies to the Eocene, and families, at least in many cases, to the Cretaceous. Few Eocene genera can be confidently recognized in the Cretaceous and then only in the Upper Cretaceous. However, *Cucullaria* ("Nemodon"), *Trinacria*, and *Dosiniopsis*, can be definitely recognized in the Upper Cretaceous and Paleocene and, at least in the case of the last two, in the Eocene. *Ciphoxis* ("Idonearca") is a Cretaceous and Jurassic genus which survived the Cretaceous-Tertiary gap, only to disappear from the Northern Hemisphere before Eocene times. The gastropod *Drepanochilus* is another survivor from the Upper Cretaceous which soon found the Tertiary not to its liking (Stewart, 1928, p. 362). In studying *Drepanochilus* I was so surprised to find it bridged the Cretaceous-Tertiary gap, that I thought the Tertiary species might prove to be subgenerically removed from the Cretaceous type, but finding that these lamellibranchs have also survived gives me more confidence that the Early Tertiary *Drepanochilus* is correctly determined.

In the Crassatellidae, Carditidae, Nuculanidae, Lucinidae, Cardiidae and Solenidae a number of new genera and subgenera have been recognized and named. In each of these families, groups have been found which are limited to the Eocene or Eocene, while the more common genera now living in the Northern Hemisphere have not been recognized below the Miocene. Some of these Eocene groups survived into the Miocene or later, but they were on the wane at the end of the Eocene. In general, it may be said that these families have two series of genera or subgenera, one Neogene and Recent, the other, Eocene, and I think that this concept will help toward understanding the distribution of these animals. Some of the Eocene genera, such as *Crassatella*, survive to the Miocene, where however, it gives way to the Recent *Eucrassatella*; while in the Lucinidae, *Eomiltha* appears to be still living in the Mozambique Channel, while *Plastomiltha* survived into the Pliocene of Florida. *Pseudomiltha* seems to be confined to the Eocene, and in America to the Eocene. *Miltha* itself, however, has not been found earlier than the Miocene and now lives only in American waters. Its appearance in the New Zealand Tertiary is interesting. Of the Cardiidae,

typical *Trachycardium* seems to have been confined to the warm waters of America, and may be traced to the Miocene. A number of different subgroups may be recognized in this genus while *Acrosterigma*, which has been associated with *Trachycardium*, proves to be a distinct group, now virtually circumtropical and known from the Miocene of America. These two groups, as well as the *Fragum*-like *Trigoniocardia* which is known from the Miocene to Recent in American tropical waters, have not been found in the Eocene, where the family is represented by genera which seem to have little in common with them.

Although it has not been possible to examine the Tertiary history of the Tellinidae, it seems very likely that it will be found to contain early and late Tertiary groups of genera as have the other families. Of the Veneridae it at least appears that the Dosininae were not present in the Atlantic ocean until the Neogene, while the Pitarinae, which are not so well represented in the American Neogene temperate faunas, were the dominant Venerids of the Eocene. Their place in the Neogene seems to have been taken by the Venerinae.

In the Nuculanidae the cold water genus *Nuculana* ("Leda") has not been recognized in the Eocene, the numerous species so determined having proved generically distinct from *Nuculana*. The presence of this genus in the Eocene, with so many genera which, where they have survived at all, have survived in warm waters, would be a curious anomaly.

Since practically all the Eocene survivors are now living in warm waters it is reasonable to believe that the Eocene oceans were warmer at higher latitudes than are the present oceans. However, the survival of a once widely distributed genus in one locality does not indicate that all its former territory must have been the same as its present ecological niche. It has survived in the place which was easiest for it to live and this may represent the optimum locality for the animal in former times or it may be an isolated spot where, for various reasons, including the absence of enemies it has not yet become extinct. The effect of temperature upon the Recent distribution of Mollusca is very striking, and the manner in which this distribution was affected by the Pleistocene glaciation leaves little doubt but that inferences on the temperatures of the past may be reasonably based on the former distribution of living species. No doubt inferences on the temperatures of the past may be also based, with a corresponding decrease in accuracy, on the distribution of larger groups, particularly subgenera, but in the numerous inferences which have been made, this decrease in accuracy has not been stressed, if mentioned at all. Most of the criticisms raised by Edwin Kirk, "Fossil Marine Faunas as Indicators of Climatic Conditions" (Smiths. Inst. Ann. Rep., 1927, p. 299-307) against current interpretations of Paleozoic climates, may be also raised against too hasty conclusions on Eocene climates.

Other factors outside changes of temperature have affected the distribution of Mollusca as suggested by the Tertiary history of the Caribbean fauna. The absence of a large number of Miocene genera from the present West Indian fauna, and their presence on the west coast of Central America is an important problem in molluscan distribution. It seems particularly interesting because it is questionable whether a change of temperature can account for the extinction of these genera in the Atlantic. According to Woodring (Carnegie Inst. Wash. Pub. 385, 1928, p. 25, 28) this extinction took place after the Caribbean Sea and the Pacific were separated and, as he suggested, may be somehow connected with the exclusion of Pacific waters from the Caribbean. If the Pacific currents were bringing an important part of the food supply into the Caribbean Sea, the absence of this food might lead to the extinction of many forms which would still be able to live in the Pacific. Presumably the weakest genera would be the first to go, and it would therefore be interesting to know the early history of the genera which failed to survive in the Atlantic, particularly as to whether they are Eocene genera. This problem has not yet been worked out but, while a few of the extinct genera may be of the Eocene, the older forms do not predominate to such an extent as to give any suggestion that it was the older forms which were selectively affected. In fact what little evidence there is tends to suggest that it was the younger genera which tended to become extinct. Woodring has suggested that the Caribbean Miocene forms which failed to survive were newcomers into that region from the Pacific (Wash. Ac. Sc. Jr. 16, 1926, p. 77). This problem seems of more than local interest and it is hoped it will be more fully investigated in the near future.

If refrigeration of the poles were the only factor involved in the extinction of Tertiary molluscan genera more Eocene genera should now be living in the tropics. It seems very doubtful if their extinction there can be attributed to overcrowding for presumably these animals were well established in the tropics during the Eocene and were supplying the biota with as many individuals as could be supported. Therefore the death of individuals in higher latitudes would not cause an increase in the tropical population. If anything, it would probably cause a slight decrease. Perhaps these extinct Eocene genera have fallen before the competition of better adapted forms but it is difficult to recognize better adapted forms, at least among lamellibranchs, and it is still possible that species like individuals grow old and die. If senility is a disease, perhaps it attacks the germ cell also or tends to overtake the individual before it reaches sexual maturity. While the causes of senility are not known, individuals do grow old and die, and their death is not necessarily brought about by competition with better adapted relatives or enemies.

The important rôle of lamellibranchs in the study of animal communities of the sea bottom is now generally recognized as well as the importance of these communities to stratigraphic paleontology. Data on the living fauna may be readily applied to the Neogene horizons but when attempt is made to apply them to Eocene horizons it will be important to know the morphological relationships of the living and fossil species. If the gaps between the living and fossil species are so great as to warrant generic separation the differences must be taken into consideration in any attempt to work out the ecology of the dead by analogy with the living.

In the important work of Ford on the animal communities of the sea bottom around Plymouth (Jr. Mar. Biol. Ass. n. s. v. 13, 1923, p. 164-224) two communities were differentiated, one in fine deposits and the other in shelly gravel. The first was divided into sub-communities which could be also correlated with the type of sediment or depth of water. Perhaps the two main communities of Ford correspond to geological facies while the sub-communities might be called communities but, since the difference is one of degree, this distinction between facies and communities is quite arbitrary. It is probably better to use facies in a general sense for the type of deposit and communities for the association of particular species. While communities may thus be smaller units within a facies, one community might also include a facies, being the biological expression of that facies. Ford's results when applied to Tertiary stratigraphy and to earlier horizons may yield important information.

Though not familiar with Ford's work, an important discussion of Tertiary facies and communities is that of M. René Abrard, resulting from a study of the strand at the mouth of the Gironde and the comparison thereof with the Eocene of the Paris basin (Abrard, Arch. Mus. d'Hist. Nat. (6) v. 2, 1927, p. 81-109). Abrard discussed the difficulties in recognising the communities, *associations*, in paleontology and emphasized the difference between living communities and the *associations paléontologiques* which, in almost all cases, are modified by the transportation of dead shells. However, at least in the case of *Trochus crenulatus* and *T. ornatus*, Abrard seems to have two Eocene communities (p. 102-103). This important work seems to be most happily applied to the *Sables moyens*, whose different facies have been exaggerated, but it is another question whether it will permit the suppression of the Bartonien or as M. Abrard stated "de débrouiller l'édifice branlant et incohérent que constituent les soi-disant niveaux du Bartonien parisien." According to Dollfus, the *Sables moyens* (Bartonien s. l.) rests disconformably upon the *Calcaire grossier* (Lutétien) from Château-Thierry to Gisors (Soc. Géol. Fr. Bul. (4) v. 24, 1924, p. 112) and Abrard likewise recognized this disconformity (Le Lutétien Bas. Paris, Angers, 1925, p. 63). Evidently the fauna of these two stages is not so

distinctly separated and this is also true of the Claiborne and Jackson stages. If the Bartonien is to be considered the upper part of the Lutétien the Jackson may be regarded as the upper part of the Claiborne. Such a classification seems chiefly of academic interest at the present time and no doubt stratigraphers, with considerable justification, will continue to recognize the Bartonien and the Jackson.

VIII. CLASSIFICATION OF THE LAMELLIBRANCHIA

The orders used are those of Pelseneer with modifications taken from the work of Ridewood and Dall. Pelseneer's classification first appeared in 1889 (Bul. Sci. France Belgique, v. 20, p. 51) and was elaborated a few years later in his "Introduction à l'Étude des Mollusques" (An. Soc. Roy. Malae. Belg. v. 27, 1892, p. 158-200). After the work of Ridewood (Phil. Tr. Roy. Soc. Lond. v. 195B, 1903, p. 147-284) Pelseneer modified his classification to the extent of giving up the Pseudolamellibranchia, and in this form it was published in Lankester's "Treatise on Zoology" (v. 5, 1906). I have used the 1906 arrangement except for the Septibranchia. This highly modified group was placed by Ridewood in the Eulamellibranchia which, with part of the Pseudolamellibranchia, he called the Synapto-rhabda. The resemblance of the Septibranchia to the "Anatinacea" = Pandoracea³ seems to indicate a genetic relationship and it was on this ground that Ridewood suppressed the Septibranchia. Apparently the structure of the gills does not warrant separating the Pandoracea from the Eulamellibranchia but the shell characters tend to support such an arrangement and the Pandoracea and Septibranchia have long been placed together by Dall as the Anomalodesmacea. The Anomalodesmacea, when first proposed by Dall (Am. Jr. Sc. (3) v. 38, 1889, p. 460—U. S. Nat. Mus. Bul. 37, 1889, p. 26+erratum) included *Solenomya* and the Myacea and Adesmacea but these forms were removed at least as early as 1895 (Tr. Wag. Inst. Phila. v. 3, pt. 3, p. 529) when the Anomalodesmacea was restricted to much the same group as used by Dall in Eastman's "Text-book of Paleontology," 1896.

While the Anomalodesmacea is perhaps not so well established as the other orders the use of this term seems more satisfactory than the complete

³ The name *Anatina* was apparently first validly used as a generic name in 1817 by Schumacher (p. 125) for a mactroid shell called *Labiosa* (Schmidt) Møller 1832 by Dall (1898, p. 906) and cannot be used for *Solen anatinus* Linné (Chemnitz, Conch-Cab. v. 6, 1782, p. 62, pl. 6 fig. 46-48). *Anatina* Schumacher is presumably earlier than *Anatina* Oken (Isis, 1817, p. 1166) which I consider a *nomen nudum*. *Solen anatinus* was designated type species of *Laternula* "Bolten" Roeding (Mus. Bolt. 1798, p. 155) by Gray (P. Z. S. 1847, p. 190). Disregarding the "Museum Boltenianum" the valid name for it would be *Auriscalpium* Megerle 1811. It is therefore necessary to have a new name for the Anatinacea and Pandoracea is here proposed.

suppression of the Septibranchia in Ridewood's Synaptorhabda or the separation of the Pandoracea from the Septibranchia as advocated by Pelseneer. To the discussion of lamellibranch classifications by March (An. Mag. Nat. Hist. 1912, v. 10, p. 91-115) should be added the classification of Douvillé (Bul. Soc. Géol. Fr. (4) v. 12, 1912, p. 419-467) which has been used by Davies in his "Introduction to Palaeontology," 1920.

IX. NOMENCLATURE

In applying the International Rules of Zoological Nomenclature a number of regrettable changes in American lamellibranch nomenclature have become necessary. The American nomenclature rests almost entirely upon the great work of the late William Healy Dall and during the last 25 years since its completion, few additions or changes have been made in it. Many of Dall's nomenclatorial decisions were based on the principle of "type by elimination" and since that time the principle has been discredited while the principle of "type by subsequent designation" has been written into the Rules (Article 30).

The changes proposed in this paper are not only of a strictly nomenclatorial type, that is, changes due to transfer of names from one supposed type species to another, but many changes are also due to the fact that the large generic groups such as *Leda* (= *Nuculana*) and *Cardium* used by Dall have been found to contain so many different animals, with different distributions, that it has seemed necessary to consider some of the minor groups of Dall as distinct genera. Many of these groups were originally described as distinct genera. This has been done not only because of the separate distribution of the groups but because morphological gradations between the groups have not been found. In some cases, the placing of a so-called subgenus, such as *Portlandia*, under one genus or another, has appeared to be based on such arbitrary grounds that it has seemed better to regard them as distinct genera. Many minor groups and even genera of Tertiary lamellibranchs remain to be differentiated and perhaps after that work has been accomplished, workers will be in a better position to unite certain groups under their most closely related genus, but it is most important to the paleontologist to be able to distinguish these minor groups, the broader relationships of which are often obscure even in well-preserved specimens. However, the work of discriminating the minor groups will probably proceed better if accompanied by at least a certain amount of synthesis, though it is doubtless in the synthetic work that the most individual disagreements in classification will arise. Therefore only the minor groups are the most reliable.

These minor groups often amount to the species of older writers—when they are sound species. Such was the large *Venericardia planicosta* which

is so common in Eocene deposits of both the Old and New World. It has long been evident to many students that some of the so-called members of this species were distinct from the typical, and would eventually be treated as separate species. The available evidence, however, makes it desirable to treat this group of large Eocene bivalves as genetically related and since it is likewise desirable to separate the different geographical species, the only way in which their close relationship can be shown is by recognizing that this group of shells is worthy of a superspecific name, or by treating the different species as subspecies of *Venericardia planicosta*. The latter method has often been used and has much to recommend it but when the subspecies are found to be distinct, and do not grade into one another, and themselves contain minor groups which may be treated as subspecies, then subspecies of subspecies arise, and under such conditions, it seems that it is best to treat original subspecies as separate species. If biological nomenclature is used to express the relationships of animals as they appear at any particular time, it follows that as knowledge of any group is increased, and it is desirable to express this knowledge in the nomenclature, the nomenclature will become more exact and restricted.

In the use of large genera and many subgenera and sections, the transfer of a name from one group to another such as the return, found necessary in this work, to the 19th Century concept of *Lucina*, i.e., for a species of *Phacoides* of workers of the last generation, involves changing the generic name of many, perhaps hundreds, of Tertiary and Recent species, but with the restriction of *Lucina* to the Neogene and Recent forms found mostly in the Atlantic Ocean, this change involves only a few species and is by no means so important as it would be if the broad concept of Dall's *Phacoides* were accepted. The use of subgenera seems highly desirable and necessary, but in most cases, where the relationships are not clear, it is probably better to treat the groups as genera and this seems particularly true when a large number of subgenera have been placed together rather arbitrarily, as in the case of the Cardiidae.

The names in the "Museum Boltenianum" have been accepted in this paper because that work was considered a valid source for zoological names by the International Commission (Opin. 96), but in each case the name that appears to be the next available name is given in parenthesis, for it is hoped that the Commission may some day reverse its decision. It seems to me that the issue of three or four copies does not constitute publication, but just what does constitute publication is evidently a difficult thing to establish. The Secretary of the International Commission has recently published a discussion of this question (Stiles, Science, v. 77, 1928, p. 471-478).

Some writers have recently introduced a few of the many names in the "Museum Calonnianum." That work was not accepted by the Commission on the grounds that it was not published in the sense of the Code. It seems to me that that work was not only published, but was more widely distributed than the "Museum Boltenianum." However, inasmuch as there is a definite Opinion against it (Opin. 51), the names in that work have not been used, and I believe that the work can be excluded on the grounds that it is not consistently binominal or "binary." Such generic names as *Auris Veneris* and *Auris Mustelae* show that the work was not consistently uninominal for genera, while *Patella Pileus marionis major*, applied to one of the species, seems to me to be distinctly plurinominal.

Binary but not binominal works have not generally been introduced into conchological nomenclature and are not used in this paper because I believe their validity is still doubtful. Opinion 20 of the International Commission on Zoological Nomenclature is definitely in favor of these binary works, but Opinion 89 indicates the confusion which the introduction of these works would cause in ichthyology, thus making desirable the suspension of the rules for at least some of them. Inasmuch as Opinion 20 may eventually be reversed or the rules may be likewise suspended for binary but not binominal writers on conchology, I have not attempted to apply the names of binary authors to the groups recognized in this paper. The distinction between binary but not binominal authors has been discussed by Stejneger (Smithson. Miscel. Coll. v. 77, No. 1, 1924) and by Bather (Jr. Lin. Soc. Zool. v. 36, 1924, p. 29-35). There are certainly the two different types of nomenclature but that the International Rules do not clearly distinguish between the two is evident from what has been subsequently written on the subject.

The names proposed by Poli in "Testacea Utriusque Siciliae," 1791-1795 have not been used because their introduction would give rise to a number of changes, while the validity of the names is still questionable. Since in doubtful cases, preference is to be shown to the current nomenclature, it seems more satisfactory to disregard these names. They were appropriately cited by Sherborn, "Index Animalium," for they were proposed in a binominal form. The questionable names, both generic and specific, were proposed for animals inhabiting shells for which Poli used the Linnean names. He also proposed to change the names of the shells by adding the suffix *derma* to the names of his new genera. This work has been described by Jukes-Brown (Pr. Mal. Soc. Lond. v. 8, 1908, pp. 99-103) who decided to use some of the names and disregard others, an arrangement which is not satisfactory. Dall proposed to ignore the names (Pr. Mal. Soc. Lond. v. 8, 1909, p. 251) on the grounds that Poli did not use "a binominal or Linnean system of nomenclature." Although Linné did

use separate names for the "animals" of the *Testacea* they were not new names and he did not name the "animals" binominally so it may be claimed that Poli's nomenclature is not Linnean. It is possible that these names may be ignored on the grounds that Poli proposed a system of nomenclature not Linnean, and, therefore, the names he proposed are not valid (Inter. Rules, Opin. 72). However, this interpretation is somewhat arbitrary and should be decided by the International Commission.

Oken also used separate names for the soft parts of the animals but he gave preference to the conchological names (Lehrb. Zool., 1815). His work therefore appears more Linnean than Poli's but to accept Oken's names and disregard those of Poli on such slight grounds is arbitrary, and it may be that both authors will have to be either accepted or abandoned together. However if Oken's "Lehrbuch" is to be barred most of his lamellibranch names will date from "Isis," 1817, where they are listed without the separate names for the soft parts and, in most cases, with page references to the earlier work (pp. 1166-1168).

The few lamellibranch names in the "Zoologie Analytique" and the German translation are, at most, synonyms according to the nomenclature used in this paper. The generic names of that work have been carefully studied by Iredale (Mal. Soc. Lond. Pr. 12, 1916, p. 79), who accepted them as from the original French work. I think they are better cited from the German translation but cannot deny that Opinion 39—which deals with a similar, though not identical case—supports Iredale's conclusion. The names being proposed for the soft parts of the animals rather than for the shells this work should be considered with that of Poli and Oken. Names which have been altered by addition of the suffix *ites* should also be considered with these names (see discussion of *Crassatellites*).

The nomenclatorial status of Martyn's "Universal Conchologist" should receive further consideration. A number of copies of Martyn's work have come to light (Dautzenberg, Jr. de Conch. v. 63, 1917, pp. 148-52) and the work has been sympathetically reviewed by Dall (U. S. Nat. Mus. Pr. 29, 1905, pp. 415-32; v. 33, 1907, pp. 185-192). I have accepted it heretofore but its validity is questionable. Martyn claimed that he was proposing a new system of classification and judging from the two "tables" of names that he published, it was a new system. However, it is difficult to understand the system for it was said that each genus would be designated by a letter (p. 6) but this arrangement was not carried out in the tables, where the new letters are introduced, without new generic names, and if the names are to be considered binominal, the generic name of the preceding genus must be used. Dall attempted to discover the system of Martyn but found the result so unsatisfactory "as not to repay the trouble." Although many of the names of Martyn are binomial, the generic name is

not always apparent and seems to have been added indifferently. In even the most generous interpretation of this work, the following qualification is to be found "but in nearly every case, the context, or the indicatory letters of the early plates, enable the puzzle to be solved after a little consideration" (Dall, *op. cit.* p. 429). Until definitely accepted or rejected by the International Commission, the status of this work is doubtful, for "nearly every case" is not enough to establish this work as consistently binominal. The later edition of this work published by Chenu has the same status as the original (Bibl. Conch. (1) v. 2, 1845).

The names of Meuschen and those in DaCosta's "British Conchology" have been discussed by Winckworth (Mal. Soc. Lond. Pr. 17, 1926, p. 103). I agree with Winckworth in not accepting the names of Meuschen and in accepting the bivalve names of DaCosta. Winckworth has indicated the probability that the bivalve part appeared separately and it is on this basis that the bivalve names are used, for I do not consider the univalve names consistently binominal. *Patella Pileus Morionis Major* may be considered binomial but it is not binominal, and the "genera" of the family *Buccina* seem of very doubtful validity. In the index to the univalves, which was combined with that of the bivalves, some attempt was evidently made to give the univalve nomenclature a more binominal appearance. The *Pileus* was dropped from the long *Patella* name, and the family *Buccina* became the genus *Buccinum* with the "generic" names cited as specific names under *Buccinum* and *Buccina*. Perhaps the univalve names may be considered as binominal in the index and cited from there but the author did not completely correct his nomenclature in this index. It does not seem reasonable to consider the whole of the bivalve nomenclature invalid by the inclusion of the doubtful univalve names in its index. An arbitrary Opinion will probably have to be given on this work.

The first type designations for lamellibranch genera, which I have found, are those of Bose in the "Nouveau Dictionnaire d'Histoire Naturelle," 1802-1804. Bose designated a number of type species, particularly for Lamarek's monotypic genera. Some of his statements, however, lead one to question his idea of a type species. Under *Callista* is the following statement, "Il a pour type les animaux de toutes les *Mactres* et des *venus chione, deflorée et galline*." (v. 4, 1803, p. 138.) Bose's statement is correct, for Poli did propose the name for animals rather than for the shells, and there is some justification of Bose's use of type in this sense. Under *Capsa* is found "Il [Lamarek] donne pour type de comparaison, la *Venus deflorata* Linn. qui est figurée pl. 231 fig. 3, 4 de l'Encyclopédie . . . etc." (*ibid.* p. 321). "Type de comparaison" is equivocal though Bose seems to have meant type in the modern sense. His discussion of the type species of *Cyclostoma* shows that he used "type" for the species which

represented the genus (v. 7, 1803, p. 59). I have noticed about a dozen type designations which indicate that he considered a single species as the type of the genus. However, for the most part Bosc used vernacular names only for either the species or the genus in his designations, and there are very few in which both elements are latinized. The work does not appear of great importance and is chiefly interesting in being the first, so far as known, in which type species for lamellibranch and gastropod genera have been designated. The last volume (24) contains an index to the Latin names used throughout the work and a synopsis of the Mollusca by Latreille in which are two types designations—*Mytilus hirundo* Linné, type species of *Pteria* Scopoli and *Avicula* Lamarek (p. 118) and *Ostrea lima* Linné, type species of *Lima* Lamarek (p. 119).

In the second edition of this work, the first six volumes of which are dated 1816, many more types were designated, particularly for genera proposed by de Montfort. In as much as de Montfort's generic names have originally designated type species, Bosc's designations are of no importance. In this later edition another incorrect designation has been noticed. Under *Lucina* is found "Les Venus sans dents et de Pensylvanie servent de type a ce genre" (v. 18, 1817, p. 229) but this edition also contains a statement which shows that Bosc did have the nomenclatorial concept of type. Under *Corbis* is found "*Venus* frangée sert de type a ce genre, qui renferme plusieurs espèces vivantes et fossiles" (v. 8, 1817, p. 48).

In his "Histoire Naturelle des Coquilles" (5 volumes, 1824), Bosc designated a few types (v. 2, p. 243; v. 4, p. 3, 4, 243) none of which has any effect upon present nomenclature of marine Mollusca. This work is called a new edition of an earlier work which I have not seen. Perhaps the earlier work is the one referred to by Bosc in the "Dictionnaire" (v. 7, 1803, p. 59) in which case, if the statements of type are in the first edition, they would antedate those of the "Dictionnaire." If there are no more statements of type in the first edition than in the second, the names of marine Mollusca will not be affected so far as I have been able to determine.

The "Dictionnaire des Sciences Naturelles" likewise contains a few type designations. Duvernoy and de Blainville contributed the articles on Conchology. The first five volumes appeared in 1804–1806, lacking the Supplements, and were included unchanged in the second edition, beginning in 1816. In these volumes at least one type designation has been noticed. Duvernoy cited *Harpa ventricosa* as the species which "*Lamarek* donne pour type de ce genre . . ." (v. 5, 1806, p. 404) but since *Harpa* Lamarek is a monotypic genus this citation is only of historical interest. It was mainly for monotypic genera that types were cited and therefore these citations are usually not important today. However, one of de Blainville's designations (1828) has been noticed by Winckworth (Malac. Soc. Lond. Pr. 15, 1922, p. 95).

In the "Encyclopédie Méthodique" (v. 2, 3, 1830, 1832), as well as in his "Traité Élémentaire," Deshayes also cited some types but the citations are sporadic and there is no attempt to designate a type species for each genus such as is to be found in de Montfort, Schumacher or Schmidt.

Schumacher seems to have been the first to consistently designate type species for lamellibranch genera (Essai Nouv. Syst. Test., 1817). In the systematic part of Schumacher's paper the word "type" or "types" is to be found on pp. 107, 118, 148, 172, 173, 178, and 228, and from these citations it appears that he had the modern concept of the word "type" as used in Zoological Nomenclature. Of course, he did not anticipate the rules for subsequent type designation which have been developed during the 20th Century but he considered a type as a standard of reference for the genus. From the "Discours Préliminaire" or Introduction, it appears that Schumacher considered the species which he cited under each genus and section as the type of that group "cependant on me pardonnera de trouver de tempts en tempts des observations sur les espèces, que j'ai donner pour type tant des genres que pour leur subdivision" (p. 20). In apparently no case is there more than one species cited for each of the often numerous sections into which Schumacher divided his genera and these species are evidently to be considered as correctly designated type species. Since the sections are not named uninominally, the type designations are of little importance, nor does it appear to me that the species mentioned under the first section can be considered as a type designation for the genus (see discussion under *Venus*). However, in those cases where no sections have been indicated and only one species is mentioned under a generic name, it would appear from the statement in the introduction, quoted above, that that species is a definitely designated type "rigidly construed."

A paper by Schmidt contains many type designations for the genera of Bruguière, Lamarck, and Megerle von Mühlfedt. This paper has been overlooked for it was of little importance until subsequent type designations were accepted as irrevocable. Since Herrmannsen did not know the paper it may be rare and the full title is here given "Versuch | über | die beste Einrichtung | zur | Aufstellung, Behandlung und Aufbewahrung der verschieden Naturkörper und Gegenstände der Kunst, vorzüglich der Conchylien-Sammlungen, | nebst kurzer Beurtheilung | der conchyliologischen Systeme und Schriften | und einer | tabellarischen Zusammenstellung und Vergleichung | der | sechs besten und neuesten conchyliologischen Systeme, welchen ein Verzeichniss der am meisten bekannten Conchylien angehängt | ist, wie solche nach dem Lamarkischen System | geordnet werden können. | Von | Friedrich Christian Schmidt | in Gotha.

Gotha, | bey Justus Perthes 1818." Schmidt's idea of a type species was

probably borrowed from de Montfort and he suggested that there should be three types for each genus, including a *maximum* and *minimum* type which would indicate the limits of the genus (p. 39), but he did not attempt to designate such types. He had a definite idea of a type species as representing the genus and distinguished between species cited as *typus* and as examples (p. 245). Many of his type designations are invalid however, for he designated type species of genera, as used by each author, thereby often citing two different species as the type of the same genus. No type was designated for *Venus* Linné, or *Venus* Bruguière, but *V. verrucosa* was designated type species of *Venus* Lamarck, and *V. dione* was designated type species of *Venus* von Mühlfeld (p. 57). Had Schmidt designated a type species for *Venus* Linné it would have to be accepted—provided it was in the original list—regardless of the types he might have designated for the genus as used by later authors. But since no type was fixed for *Venus* Linné and the types designated for *Venus* Lamarck and *Venus* von Mühlfeld are both in the original *Venus* it cannot be held that Schmidt fixed the type species of *Venus*.

No type was designated for *Corbula* Bruguière while for *Corbula* Lamarck *C. sulcata* Lamarck was designated type (p. 77), with a reference to the original appearance of *Corbula* (Encyclop. tab. 230, fig. 1a, b, c). Since this is the only species designated type species of *Corbula* by Schmidt it seems to be a valid type designation. Schmidt designated *Ostrea maxima* type species of *Pecten* Lamarck but designated eight different species for the sections of *Pecten* von Mühlfeld. Since the only species designated by Schmidt which was in the original *Pecten* Müller is *Ostrea maxima* it may be held that Schmidt fixed the type species of *Pecten*. Fortunately the same type follows whether Schmidt's designation be accepted or not, because the next designation, that of Children, is also *O. maxima*. It is perhaps necessary to note that *O. opercularis* was doubtfully placed under *Pecten* by Müller. Although Schmidt designated numerous species for *Pecten*, there is only one valid type designation and I think it is to be accepted. There is certainly room for differences of opinion on such a designation which would seem to owe it validity to circumstance. From the point of view of Schmidt and his contemporaries it could hardly be held that Schmidt had fixed the type species of *Pecten* Müller but from the present Rules Schmidt's designation seems valid. If his designation be ignored and the species designated by the next subsequent author be accepted there would still remain the fact that at an earlier date another author had cited one of the original species as type of the genus. Schmidt designated *Arca noae* as type species of *Arca* Lamarck and I think this is a valid type designation, for the species he designated as type of *Arca* von Mühlfeld is not in the original list. However

Schumacher's designation is a year earlier. As in the case of *Venus*, Schmidt's type designation for *Ostrea*, *Pinna*, *Mytilus*, *Cardita*, *Tellina*, *Macra* and others cannot be accepted. Schmidt evidently favored the Lamarckian nomenclature over that of von Mühlfeld, at least for *Venus* (p. 60), and his Lamarckian types might be accepted as types for Linnean genera, but he did not place Megerle von Mühlfeld's name in synonymy and it therefore seems that most of his types designations are not to be accepted.

It was doubtless after the publication of this work that Schmidt bought the Bolten collection of Hamburg, which, at his death, was acquired by the Art and Natural History Museum of Gotha (Müller, *Isis*, 1832, p. 127). Presumably this collection is still preserved in Gotha, but it is only of historical interest since the new species of the "Museum Boltenianum" were not diagnosed and are only identifiable through the figures cited by Roeding.

Anton's type designations in his "Verzeichniss der Conchylien," 1839, have also been overlooked. Each of the genera and subgenera of Anton's list contains one species which is printed in small capital letters and this species is a designated type species for the genus or subgenus in which it is placed, as stated in the introduction. In reference to genera the following statement occurs "(deren Typusart mit Versalbuchstaben gedruckt ist);" (p. vi). Anton had a modern idea of type, as the species representing the genus (p. v), but for a number of genera he chose species not in the original lists. He used the name of the genus for the typical subgenus and for none of the lamellibranch names is there more than one type designated. For the genera in which only one named species is listed that species is not printed in uppercase letters, and for the lamellibranch genera, at least, these are the only superspecific names for which no types were designated. It is quite possible that Anton regarded the single species as the type but there is no statement to that effect and these citations are therefore not subsequent type designations. In the gastropods, besides genera and subgenera, sections were sometimes recognized, as for *Helix*, *Clausilia*, and *Voluta*, but no types were indicated for these sections. The last page of Anton's paper contains this statement "im Druck beendigt den 9. October 1838." and it is possible that this paper was issued late in 1838 rather than 1839.

The type designations of Fleming, Children, Herrmannsen, and others, have been discussed by Kennard and Woodward (*Malac. Soc. Lond. Pr.* 15, 1922, pp. 47-51). Herrmannsen certainly made a number of incorrect type designations but they do not invalidate those which are correct. Children and Gray also made incorrect type designations as have later writers. It may be noted that Children thought the first species cited by

Lamarek was "his type" but this concept does not indicate that he had an incorrect idea of *type* but rather that he failed to anticipate some of the modern rules of subsequent type designations. The date of Fleming's article on Conchology in the Supplement to the "Encyclopedia Britannica" may be 1819 instead of 1818 for the last page of volume 3 contains this note, "Printed by George Ramsay and Company | Edinburgh, 1819." A few unimportant type designations have been noticed in the first American edition of Brewster's "Edinburgh Encyclopaedia," Philadelphia, 1832, v. 13, pp. 656-693, article on Mollusca by J. F. (Fleming), and they are presumably in the earlier original edition.

I am indebted to Dr. Baker for calling my attention to the sporadic designations of von Martens in the "Zoological Record." It is not practical to list all the authors who have made sporadic type designations but it may be well to call attention to those of Crosse and Fischer—mostly for new generic names—in their reviews published in the "Journal de Conchyliologie." Among those of the first three quarters of the 19th Century who designated type species for genera of marine Mollusca are Bose, Latreille, Duvernoy, de Montfort, de Blainville, Schumacher, Schmidt, Fleming, Children, Deshayes, Rang, Anton, Herrmannsen, Gray, Woodward, Leach, Philippi, Chenu, Jeffreys, Crosse, von Martens, Meek, Gabb, Conrad, Tate, Römer, Tryon, Pfeiffer, Dall, and Stoliczka. Doubtless there are others.

A fair example of the need for teaching students of Paleontology the rudiments of the International Rules of Zoological Nomenclature is to be found in a recent discussion of the name *Agasoma* (Wiedey, San Diego Soc. Nat. Hist., Tr. 5, 1928, p. 113). It is claimed that Cossmann's subsequent designation of a type species for *Agasoma* may be disregarded because his statements do not constitute a revision of the genus. Whether Cossmann did or did not revise the genus *Agasoma* has no bearing on the fact that he designated a type species. Article 30 II g, which deals with 'type by subsequent designation' is explicit, "any subsequent author may select the type, and such designation is not subject to change." The rare occurrence of the species selected by Cossmann as well as the fact that it is not the first species or "chef de file" have no bearing on this case. The fact that species have been placed in the genus which are not congeneric with the subsequently designated type species is likewise beside the point. In fact not one of the objections brought forth against Cossmann's designation is relevant and they could only be advanced by one who is not familiar with the Rules. A student is quite at liberty to invent rules of his own, or work without any, but he should at least be familiar with the International Rules and when his own curiosity does not lead him to them, they should be thrust upon him by his instructors. The Rules have been reprinted by the Biological Society of Washington in its Proceedings, vol. 39, 1926, p. 75.

The synonymies given for the species are not complete, though it may at least be said that they are more complete than those published for the gastropod species. To the list of catalogues not cited in synonymy should be added the supplement to Boyles' Catalogue (Whitney, Bibliography and Index of North American Mesozoic Invertebrata, Bull. Am. Pal. v. 12, 1928, pp. 50-494). I have also failed to list the names cited by Hertlein and Crickmay in their paper entitled "A Summary of the Nomenclature and Stratigraphy of the Marine Tertiary of Oregon and Washington" (Am. Phil. Soc. Pr. 64, 1925, pp. 224-282). Most of the faunal lists of this useful summary seem to have been taken from the literature but perhaps it does contain some original information.

X. LIST OF NEW GENERIC AND SUBGENERIC NAMES

- Agnomyax*, new genus, type species, *Tellina monilifera* Gabb (?Garidae).
Bathytormus, new genus, type species, *Crassatella protexta* Conrad (Crassatellidae).
Calorhadia, new genus, type species, *Leda pharcida* Dall (Nuculanidae).
Claibornites, new genus, type species, *Lucina rotunda* Lea (Lucinidae).
Halonanus, new genus, type species, *Noetia pulchra* Gabb (Glycymeridae).
Microcallista, new genus, type species, *Cytherea proxima* Deshayes (Veneridae).
Rhectomyax, new genus, type species, *Asaphis undulata* Gabb (Family ?).
Agnocardia, new subgenus of *Trachycardium*, type species, *Cardium clai-bornensis* Aldrich.
Americardia, new subgenus of *Trigoniocardia*, type species *Cardium medium* Linné.
Codalucina, new subgenus of *Claibornites*, type species, *Lucina uncinata* Defrance.
Compsomyax, new subgenus of *Venerella*, type species, *Saxidomus gibbosus* Gabb = *V. subdiaphana* (Carpenter).
Dallocardia, new subgenus of *Trachycardium*, type species, *Cardium quadrigenerium* Conrad.
Delectopecten, new subgenus of *Palliolum*, type species, *Pecten vancouverensis* Whiteaves.
Eophysema, new subgenus of *Loripinus*, type species, *Lucina subvexa* Conrad.
Eosolen, new subgenus of *Solena*, type species, *Solen obliquus* Deshayes = *Solena plagiaulax* (Cossmann).
Glyptoactis, new subgenus of *Venericardia*, type species, *V. hadra* Dall.
Hybolophus, new subgenus of *Eucrassatella*, type species, *Crassatella gibbosa* Sowerby.
Leuroactis, new section of *Venericor*, type species, *Venericardia pilsbryi* new species.
Litorhadia, new subgenus of *Calorhadia*, type species, *Leda acala* Dall.
Mexicardia, new subgenus of *Trachycardium*, type species, *Cardium procerum* Sowerby.
Nanonavis, new subgenus of *Parallelodon*, type species, *Grammatodon carinatus* (Sowerby) Woods.

- Neitheops*, new subgenus of *Neithea*, type species, *N. grandicostata* Gabb.
Pegophysema (*Lucina* Fischer, not Bruguière), new subgenus of *Loripinus*, type species, *Lucina schrammi* Crosse.
Phlogocardia, new section of *Trachycardium*, type species, *Cardium belcheri* Broderip and Sowerby.
Plastomiltha, new subgenus of *Miltha*, type species, *Cyclas claibornensis* Conrad.
Portlandella, new subgenus of *Portlandia*, type species, "*Leda rosa*" Hanna.
Quasilucina, new section of *Lucina*, type species, *L. carinifera* Conrad.
Saxolucina, new subgenus of *Claibornites*, type species, *Lucina saxorum* Lamarek.
Schedocardia, new subgenus of *Plagiocardium*, type species, *Cardium hatchetigbeense* Alrich.
Schedotrapezium, new subgenus of *Trapezium*, type species, *Trapezium carinatum* Gabb.
Stereomactra, new subgenus of *Spisula*, type species, *Schizodesma abscissa* Gabb.
Venericor, new subgenus of *Venericardia*, type species, *V. planicosta* Lamarek.

It has long been claimed and will no doubt be repeated that the chief motive behind the proposal of new generic names is the proposer's desire to perpetuate his own name. This would surely be true of those who make such claims but usually the authors of such views do not propose new names. It is now customary in systematic reports to cite the name of the author and the year of publication after the generic name as a brief reference. It seems to me that this citation is a temporary expediency, very helpful at present but certain to disappear. It is the object of nomenclatorial investigations to make such citations unnecessary and all the sound systematic work of the past has helped to reach that goal. Some systematic names are now so firmly established that there is little necessity for citing the references after them and in the future more such names will become established. Theoretically at least, systematists are working for a nomenclature in which no references will be necessary and therefore, from the point of view of their critics, are digging their own graves. Systematists know this and the fact that they go on working shows that they are not greatly concerned about their "immortality." The degree of immortality held out to the proposer of a new generic name is not of a high order. He may see his name cited after the generic name for a few years as a sort of introduction to the new name and if he lives long enough may see the generic name so firmly established that it may become rather an introduction to his own name. When the new name becomes established his own name will no longer be necessary to introduce it and his name will eventually disappear. His original proposal will be completely lost sight of by all but the most erudite and eventually even by them.

The more thoroughly he does his work the less controversy develops around it and the less contemporary notice is given to it. The notoriety which sometimes follows poor work is surely not sought after. If the name does not represent an entity to which it is desirable to refer to as such it is obvious that the name will disappear. An author can only propose a new name and use it himself. If others use it presumably there is need for it and its proposal becomes justified. One generation may find it convenient to use names for certain forms in which a later generation, due to its different outlook, has no interest. Or a given generation of the biological profession may find use for the names proposed by the systematist of an earlier generation. This lag of the profession in general seems to be a natural thing and not without some advantages. The importance of the proposal of new systematic names is often exaggerated and chiefly by the critics of systematic work.

XI. ADDITIONS AND CORRECTIONS TO THE PAPER ON GABB'S TYPE GASTROPODS

It is not practical to go over the earlier paper at this time but the following notes may be of interest.

The genus *Galeodea* known to be still living in the Eastern Atlantic also appears to have survived in Japanese waters (Dall, U. S. Nat. Mus. Pr. 66, 1925, p. 17, pl. 34, fig. 4).

The genus *Sceptrum* was present in the early Eocene or Paleocene of Belgium—“*Tudicula*” *dejaeri* Vincent, An. Soc. Malac. Belg. v. 28, 1893, p. 31, pl. 1, fig. 5–8, Panisélien—Londinien.

The type species of *Cerithium* was discussed by Buequoy, Dautzenberg and Dollfus (Moll. Roussillon, v. 2, 1898, p. 769) who considered, as did Vignal, *Cerithium adansonii* Bruguière as the type species. They considered the species very close to *C. nodulosum* while Vignal, in a paper on *Cerithium s.s.* (Jr. de Conchyliologie, v. 68, 1923, pp. 14–20) accepted as *C. adansonii* the species so identified by Kiener (Coq. Vivantes, *Cerithium*, 1841, p. 9, pl. 4, fig. 2). Kiener gave as the locality “les côtes du Sénégal” but whether that locality refers to the actual specimen figured by him or was taken from Adanson is not certain. Kobelt has reproduced Kiener's figures (Conch.-Cab. Abt. 26, Bd. 1, *Cerithium*, 1895, p. 142, pl. 27, fig. 4, 5), which represent a species evidently related to specimens in the Academy from the Caroline Islands labelled *Cerithium echinatum* Lamareck = *C. rubus* Martyn. Woodring has recently indicated the difficulty involved in discovering the exact nature of *Cerithium s.s.* (Carnegie Inst. Wash. Publ. 385, 1928, p. 333) and until someone has made a satisfactory identification of the type species it will remain in doubt. Bruguière considered *C. adansonii* closely related to *C. nodulosum* and

though the outer lip was evidently not produced over the anterior canal as on that species, *C. adansonii* may be related to *C. nodulosum* for the extension of the outer lip does not seem of much systematic importance although it may characterize a separate section of *Cerithium*.

Most of the species which I called *Euspirocrommium*, as a subgenus of *Amaurellina*, have been considered a distinct genus by Woodring and named *Pachycrommium* (Carnegie Inst. Wash. Publ. 385, 1928, p. 391). While I think there is some doubt about *Euspirocrommium*, until better preserved material is available it will probably be better to use the name *Pachycrommium* for these species. *Amaurellina spirata* is smaller than *Pachycrommium* but of the Academy's two large specimens the larger is 26 mm. high (no. 8341). Specimens of *Pachycrommium guppyi* from Santo Domingo (no. 2881a) have a fine spiral sculpture of punctate lines on the body whorl at least, and on *P. acuminatum* similar but more widely spaced lines may be seen without magnification. *Amaurellina* and *Pachycrommium* are closely related but perhaps not more so than the other genera of Ampullinae and the presence of an umbilicus may be considered of generic importance, although I did not think so at a time when more specimens of this group were available to me than are at present.

My recognition of *Ampullina s.s.* in the Oligocene and Miocene was based on *Ampullinopsis*. If *Ampullinopsis* is subgenerically distinct from *Ampullina*, then, so far as I can discover, *Ampullina s.s.* was confined to the Eocene, and *Ampullinopsis* was Oligocene and Miocene. *Ampullinopsis* seems to be a direct descendant of the Eocene *Ampullina* but none of the Eocene specimens examined has the callus spread out in quite the same manner as on *Ampullinopsis*, and on this character *Ampullina* may be divided into the Eocene typical *Ampullina* and the Oligocene and Lower Miocene section *Ampullinopsis* but it would be misleading, I think, to cite *Ampullinopsis* as an important Lower Oligocene addition to the Ampullinae because the gap between *Ampullina* and *Ampullinopsis* is very small. The uncovered condition of the umbilicus of the large specimens from the Lower Miocene of Tampa, Florida, is probably due to erosion.

In regard to *Tylostoma* I have since noticed that White referred to *T. torrubiae* as Sharp's type species (U. S. Nat. Mus. Pr. 3, 1880, p. 142).

Buccinum undatum Linné, which I designated as type species for *Tritonium* Müller, because of the possible use of the name *Tritonium* for species long known as *Neptunea*, was designated as type species for *Tritonium* by Schumacher in 1817 (Essai Syst. Test., p. 209).

Ficus mamillatus, *F. modestus*, *F. decussatus* and *F. nodifer* should be corrected to *Ficus mamillata*, *F. modesta*, *F. decussata* and *F. nodifera*. *Priscoficus caudatus* should be *P. caudata*. The name *Ficopsis angulata*, being a subjective synonym of "*Pyrula angulata* F. E. Edwards, 1806, in

Lowry's *Chart Char. Tert. Foss.*, p. iv,"³ cannot be used for the angular form of *Ficopsis remondii*. For the angulated form in the Crescent formation the name *F. remondii* var. *crescentensis* Weaver and Palmer is available, and this name may prove to be the correct name for the angulated forms in California.

Perissolax trivolvæ (Gabb), the type species of *Perissolax* Gabb, 1861, now proves to be an Eocene species of the genus for which I used the name *Pseudoperissolax* Clark, 1918. Lately the upper three formations of the New Jersey Cretaceous section, the Hornerstown marl, the Vincentown sand, and the Manasquan marl, containing the "Jerseyian fauna" have been shown to be of Eocene age (Cooke and Stephenson, Jr. *Geol.* v. 36, 1928, p. 139). This change has suggested a re-examination of *Perissolax* which I too hastily called "a close synonym of *Pyropsis*." The type specimen of *Perissolax trivolvæ* is in the Academy's collections. It is an internal cast from the Yellow limestone on Timber Creek (Gabb, *Pr. Ac. Nat. Sc. Phila.* 1860, p. 94, pl. 2, fig. 5, as *Fusus*) which has been re-described and refigured by Whitfield who cited it from "the yellow limestone sand of the Middle Marls (U. S. *Geol. Sur. Mon.* 18, 1892, p. 172, pl. 21, figs. 1-3). According to Weller it is from the Vincentown lime sand (*Geol. Sur. N. J. Cret.* 1907, p. 731, pl. 85, fig. 6). The cast may be compared to *Perissolax eocensis* (Aldrich) from the Wilcox of Alabama, Gregg's Landing (Harris, *Am. Pal. Bul.* 3, 1899, p. 65, pl. 8, fig. 13, as *Triton* (*Ranularia*)). The proportions are similar, each has the three angulations and the anterior expansion of the inner lip of *P. eocensis* is indicated on the cast by an impression. The cast does not show the crenulated shoulder but Whitfield has figured another specimen showing the crenulations. It seems reasonably certain that *P. trivolvæ* and *P. eocensis* are congeneric. *Pseudoperissolax blakei* (Conrad), the type species of *Pseudoperissolax*, is also congeneric with *Perissolax eocensis*, thus making *Pseudoperissolax* a subjective synonym of *Perissolax*. The California species may now be listed as *Perissolax blakei* (Conrad) the name by which it was known for more than half a century. Besides the American Paleocene and Eocene species the genus *Perissolax* is also known from the Eocene of Japan for "*Fusus*" sp. from the Miike Coalfield (Yokoyama, Jr. *Coll. Sc. Univ. Tokyo*, v. 27, no. 20, 1911, p. 10, pl. 2, fig. 7) is a

³ I have not seen this reference and have copied it from a recent paper on the Ficidae (Wrigley, *Mal. Soc. Lond. Pr.* 18, 1929, p. 241). In this important study of the Ficidae the author has preferred to call *Priscoficus* and *Ficopsis* "main groups" of *Ficus*, not even recognizing them as subgenera. *Priscoficus* seems sufficiently close to *Ficus* to be included in the Ficidae but a closer relationship is doubtful. It is much more convenient to speak of *Priscoficus* than of "The nodosely carinated species of Early Eocene times."

Perissolax as was recognized by Dickerson (Pr. Cal. Ac. Sc. (4) v. 11, 1921, p. 25).

Heteroterma and *Perissitys* (as *Perissolax*) have been recognized by Marshall and Stanton in the Wangaloa Beds of New Zealand (Marshall, Tr. N. Z. Inst. v. 49, 1917, p. 453, pl. 35). The comparisons of Stanton indicate that the New Zealand species are not closely related to the California species, and though they do have at least superficial resemblance, it may be doubted whether they are really congeneric.

"*Acteonia*" *calafia* has a shorter spire than *Trajanella* Popovici-Hatzeg 1899 (Cossmann, Es. Pal. Comp. v. 8, 1909, p. 107, pl. 2, figs. 16-18), but it is otherwise so similar to that genus that I think it may be reasonably cited as *Trajanella calafia*.

Through the kindness of Dr. Stanton, and Dr. Reeside who first called my attention to a copy in the Library of the Smithsonian Institution, I have been able to examine the German translation of Sowerby's "Mineral Conchology." *Euspira* and *Rimella* were unavoidably cited from the French edition of this work though the German edition had been given priority by Sherborn.

Euspira is proposed in the same manner in both translations, *Natica glaucinoides* and *Natica depressa* ?Lamarck Sowerby being placed in the genus on pages 14, 15 and 17. *Ampullaria sigaretina* Lamarck, not being cited until page 321, was therefore not placed in the genus *Euspira* until 1842 according to Sherborn's findings for the dates of the separate parts of this work (Index Anim. 1922, p. cxviii). In a recent discussion of *Euspira* the fact that the translations appeared in parts was evidently not taken into consideration (Finlay, N. Zeal. Inst. Tr. Pr. 59, 1928, p. 248).

Rimella is treated identically in both translations even to the page reference. I notice, however, that my former statement that Agassiz had excluded the living species from *Rimella* is incorrect. He stated that it was not conspecific with the fossil *R. fissurrella*, but did not necessarily exclude the living species from the genus *Rimella*. In fact it is almost certain that Agassiz considered the living species a *Rimella*. However, in spite of Linné's attributing *Strombus fissurella* to the Indian Ocean, Hanley has shown that the specific name must go with the fossil (Ipsa Linn. Conch. 1855, p. 274).

Addendum.—The paper by Dr. Takumi Nagao on the Palaeogene (Eocene) of Kyûshû, Japan, arrived—February, 1929—too late to be considered in the systematic part of this work (Sc. Rep. Tôhoku Univ. (2) Geol. v. 12, no. 1, 1928). Many of the Japanese species are compared to related species in California. The discovery of *Noetia* in beds of Eocene age—Doschi Beds (p. 26, 27, pl. 6, figs. 8-10, associated with *Venericor*, p. 55) seems particularly interesting and likewise the genus *Dosinia* in the Ashiya

Group (p. 64, pl. 10, figs. 4-7, 9). The Ashiya Group was considered of Oligocene age by Nagao but such an early age for the Ashiya fauna seems questionable. The fauna was said to resemble that of the Oligocene of North America but also to be more closely related to the Japanese Neogene than to the Eocene fauna—Manda and Okinoshima beds, p. 9, 137. Both the stratigraphy and fauna, according to Nagao, indicate an important break prior to the deposition of the Ashiya Group and this break seems to correspond more closely to the break between the Neogene and Eocene than to the minor gap between the Oligocene and the Eocene. Since the fauna of the Ashiya Group is so closely related to that of the Neogene, I think the Ashiya Group should be considered Neogene, corresponding, perhaps, to the Aquitanien. Should this suggestion prove acceptable it would increase the importance of *Dosinia* as a guide fossil for the Neogene of the Northern Hemisphere.

XII. ALPHABETICAL LIST OF AUTHORS CITED BY THE DATE OF PUBLICATION

The citation of an author by date may also refer to the preceding synonymy.

ANDERSON, F. M.

1902, Cretaceous Deposits of the Pacific Coast, Proc. Cal. Acad. Sci. (3) v. 2, no. 1, pp. 1-154.

1905, A stratigraphic study in the Mt. Diablo Range of California, Proc. Cal. Acad. Sci. (3) v. 2, no. 2, pp. 155-248.

ARNOLD, RALPH

1906, The Tertiary and Quaternary Pecten of California, U. S. Geol. Surv. Prof. Pap. 47, pp. 1-264.

CONRAD, T. A.

1855, in Appendix to the Preliminary Geol. Report of William P. Blake, Article 1, Report of Conrad on the Fossil Shells Collected in California by Wm. P. Blake, etc., House Doc. 129, pp. 5-20.

1857, in Appendix to Geol. Report by W. P. Blake in Rep'ts. of Explorations and Surveys . . . from the Mississippi River to the Pacific Ocean, v. 5, 1856, pp. 317-329.

COOPER, J. G.

1894, Catalogue of California Fossils; Calif. Min. Bur. Bull. 4, pp. 5-65.

1896, List of Fossils, in Oil and Gas Yielding Formations of Los Angeles, Ventura and Santa Barbara Counties, pt. 1, Calif. Min. Bur. Bull. 11, pp. 79-87.

COSSMANN AND PISSARRO.

1904-1906, Iconographie Complète des Coquilles Fossiles de l'Éocène des Environs de Paris, v. 1.

DALL, W. H.

1898, 1900, 1903, Contributions to the Tertiary Fauna of Florida, etc., Trans. Wagner Free Institute of Sci. Philadelphia, v. 3, pp. 571-1654.

1909, The Miocene of Astoria and Coos Bay, Oregon, U. S. Geol. Sur. Prof. Pap. 59, 1909, pp. 1-278.

DILLER, J. S.

1893, Cretaceous and Early Tertiary of Northern California and Oregon, Bull. Geol. Soc. Am. v. 4, pp. 205-224.

1896, A Geological Reconnaissance in Northwestern Oregon, U. S. Geol. Sur. 17th. An. Rep. pt. 1, pp. 447-520.

GABB, W. M.

- 1864, Description of the Cretaceous Fossils, Pal. Calif. v. 1, Sect. 4, p. 57-243.
 1866, Tertiary Invertebrate Fossils, Pal. Calif. v. 2, Sect. 1, pt. 1, Feb. 1866, pp. 1-38.
 1869, Tertiary Invertebrate Fossils (continued), Sect. 1, Pt. 2, pp. 39-63; Synopsis of Tertiary Invertebrate Fossils of California, Sect. 1, Pt. 3, pp. 65-124; Cretaceous Fossils, Sect. 2, Pt. 1, pp. 125-205; Synopsis of the Cretaceous Invertebrate Fossils of California, Sect. 2, Pt. 2, pp. 207-254; Pal. Calif. v. 2.

GILLET, S.

- 1925, Études sur les Lamellibranches Néocomiens, Mém. Soc. Géol. France, n. s., v. 1, pt. 3 and 4, pp. 1-224, 1924, v. 2, pt. 1, pp. 225-339, 1925.

LAWSON, A. C.

- 1914, San Francisco Folio, U. S. Geol. Surv. Folio 193, pp. 1-24. Also published in octavo.

MARCOU, J.

- 1876, Report on the Geology of a Portion of Southern California, App. H. I., in An. Rep't. Chief Engineers, pt. 3, pp. 378-392. Published separately, pp. 158-172.

MERRIAM, J. C.

- 1895, A list of type specimens in the Geological Museum of the University of California, which have served as originals for figures and descriptions in the Paleontology of the State Geological Survey of California under J. D. Whitney. Compiled for the use of workers in California geology, Geol. Dept. University of California, Berkeley, July 1. (This paper contains 3 printed pages which are not numbered.)
 1897, The Geological Relations of the Martinez Group of California at the Typical Locality, Journ. Geol. v. 5, pp. 767-775.

MEEK, F. B.

- 1876, Rep't. Invert. Cret. Tert. Fossils Upper Missouri Country, Hayden Rep't. U. S. Geol. Sur. Terr. v. 9.

STANTON, T. W.

- 1893, The Faunas of the Shasta and Chico Formations, Bull. Geol. Soc. Amer. v. 4, pp. 245-256.
 1894, In Diller and Stanton, The Shasta-Chico Series, Bull. Geol. Soc. Amer. v. 5, pp. 435-464.
 1895, Contributions to the Cretaceous Paleontology of the Pacific Coast: The Fauna of the Knoxville Beds, U. S. Geol. Surv. Bul. 133, pp. 1-132.
 1896, The Faunal Relations of the Eocene and Upper Cretaceous on the Pacific Coast, U. S. Geol. Sur. 17th. An. Rep. pt. 1, pp. 1005-1060.

STEWART, RALPH.

- 1927, Gabb's California Fossil Type Gastropods, Acad. Nat. Sci. Phila. Pr. 78, "1926" Jan. 3, 1927, pp. 287-447.

STOLICZKA, F.

- 1870-1871, Cret. Fauna of S. India, v. 3, Pelecypoda, Mem. Geol. Sur. India, Pal. Indica, ser. 6.

WATTS, W. L.

- 1874, Gas and Petroleum Yielding Formations of the Central Valley of California, Cal. Min. Bur. Bul. 3, pp. 1-100.

WOODS, HENRY

- 1899-1903, Cretaceous Lamellibranchia of England, v. 1, Paleontographical Soc. pp. 1-232.
 1904-1913, Cretaceous Lamellibranchia of England, v. 2, pp. 1-473.

WHITEAVES, J. F.

- 1874, Notes on Cretaceous Fossils, etc., Geol. Sur. Canada, Rep. Progress, 1873-1874, pp. 260-268.

- 1876, 1879, 1884, 1900, 1903, Mesozoic Fossils, v. 1, Geol. Surv. Canada, pp. 1-415.

WHITNEY, J. D.

- 1865, Geology, v. 1, Geol. Surv. Calif., pp. 1-498. Report of Progress and Synopsis of the Field-work, 1860-1864.

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